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(54) **Optical disk having electronic watermark, reproducing apparatus thereof and copy protecting method using the same**


(57) A copy protecting method for an optical medium includes a writing step (FIG. 2, S113, FIG. 3, S127) of writing watermark data (FIG. 1B, a to p) as ECC data in a data storage area (25, 11, 12, 13) of a disk (10) having a certain data stored therein.


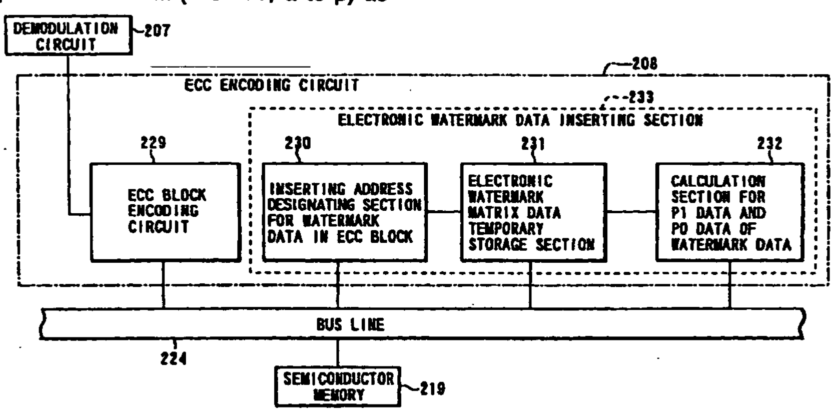


FIG. 6

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## Description

[0001] This invention relates to copy protection of recording data in a disk recording/reproducing system (medium, recording apparatus, reproducing apparatus).

[0002] Further, this invention relates to copy protection for a data recording medium which requires a dishonest copy preventing process for protection of copyright or the like.

[0003] Further, this invention relates to copy protection for a reproducing apparatus for reproducing data from a data recording medium such as an optical disk by use of convergent light obtained by converging a laser beam.

[0004] Conventionally, the copy protection technique has been used for protecting the copyright of a video software or the like. As a typical example of a software which requires copy protection, a DVD video disk and DVD-ROM disk using a digital recording system are provided (DVD is an abbreviated term for indicating a digital video disk or digital versatile disk). Conventionally, the encryption technique has been used for copy protection for the digital recording video softwares.

[0005] The copy protection method using the encryption technique is effective in the DVD video disk or DVD-ROM disk in which encrypted data is previously recorded. However, in the case of a DVD-RAM in which the user can newly record data, the following problems occur.

(1) It is difficult to manage the encryption key necessary at the time of encryption.

(2) It is difficult to attain a strong encryption process for a disk recording/reproducing apparatus (such as a DVD-RAM recorder capable of effecting the digital recording and reproducing processes like an analog video cassette recorder which is widely used) which is put under the control of the user and the encryption tends to be deciphered.

(3) In a case where the encrypting and decrypting processes can be effected on the disk recording/reproducing apparatus side, a copy of the content of data which is required to be protected from being copied can be easily made by effecting a process of decrypting data which is formed and encrypted by the user by use of another disk recording/reproducing apparatus and then encrypting the data again.

[0006] As described above, when the recording/reproducing apparatus of digital video data is considered, it is difficult to effectively attain the copy protecting function using the encryption technique.

[0007] Further, if an attempt is made to effect the copy protecting process by use of an independent method for the DVD-RAM data recording medium on the DVD-RAM driver side, there occurs a problem that the copy protection processing circuit will become complicated when the data recording medium is reproduced by use of a DVD-ROM driver or the DVD-ROM disk is reproduced by use of a DVD-RAM driver (this may cause the product cost of the DVD-RAM driver to increase).

[0008] An object of this invention is to provide a copy protection system which stably and strongly prevents dishonest copying for a recordable digital data recording medium such as a DVD-RAM disk and can be commonly used for various types of data recording media containing reproduction-only data recording media.

[0009] This invention is a copy protecting method for an optical medium comprises a writing step of writing watermark data as ECC data in a data storage area of a disk having a certain data stored therein.

[0010] And it further comprises an extraction step of extracting the watermark data from the ECC data of the disk; and a determination step of comparing the extracted watermark data with collation data and determining a validity of the disk based on the result of comparison.

[0011] Based on the above feature, this invention prevents the dishonest copying process as follows. Now, consider a case wherein a third party who wants to effect the dishonest copying of a disk attempts to dishonestly copy the disk into another disk by use of a disk reproducing apparatus and a disk recording apparatus which receives an output thereof. When the third party loads the disk on the reproducing apparatus and reads the disk, storage data such as video image is output as it is from the reproducing apparatus, but the watermark data is eliminated together with other error data by an error correction circuit since the water mark data is ECC data. Therefore, only the storage data having the electronic watermark data eliminated therefrom is output from the reproducing apparatus and supplied to the recording apparatus. As a result, the recording apparatus records only the storage data having no electronic watermark data into a new disk.

[0012] Next, if the copied disk is read by use of a reproducing apparatus having an electronic watermark collating function, the electronic watermark cannot be extracted and the collating process cannot be effected and the disk is detected as an invalid disk. Thus, a copy-protected disk which can be prevented from dishonest copying by use of a normal disk reproducing apparatus and disk recording apparatus can be attained. The electronic watermark collating process is effected before the electronic watermark data is extracted by the error correction circuit.

[0013] The copy protecting method of this invention attains the copy protecting function by eliminating the electronic watermark data at the time of dishonest copying by the third party by use of the error correction circuit which is normally provided in the DVD reproducing apparatus.

[0014] Further, this invention is an optical medium comprising a data storage area provided on a disk, for storing data; and a plurality of ECC blocks provided in the data storage area, for storing watermark data as ECC data together with a certain data.

[0015] This invention specifies a disk in which electronic watermark data used for the copy protecting method is stored. In the disk, electronic watermark data is stored as ECC data in each ECC block of the data storage area. In the reproducing apparatus, the electronic watermark data is read out and compared with the collation data. In this case, if the similarity of certain level or higher level can be attained between them, the disk is determined as a valid disk having the electronic watermark. However, if the similarity of certain level cannot be detected, the disk is determined as an invalid disk and an error is displayed and disk reproduction is interrupted.

[0016] Further, this invention is an optical disk reproducing apparatus comprising extracting means for extracting watermark data from ECC data of a disk in which the watermark data is stored as the ECC data in a data storage area of the disk having a certain data stored therein.

[0017] And it further comprising determining means for comparing the extracted watermark data with collation data and determining a validity of the disk based on the result of comparison; and output means for eliminating the error data and watermark data from the certain data based on the ECC data and then outputting the certain data.

[0018] This invention specifies the reproducing apparatus having the electronic watermark data collating function for copy protection. That is, the electronic watermark data stored as the ECC data is extracted by the reproducing apparatus and compared and collated with the collation data stored in part of the recording area of the disk, for example. In this case, if the similarity of certain level or higher level can be attained between them, the disk is determined as a valid disk having the electronic watermark, and if the similarity of certain level cannot be detected, the disk is determined as an invalid disk.

[0019] Further, since the electronic watermark data is eliminated as ECC data by the error correction circuit after the collating process, image data or the like can be recorded if the output of the reproducing apparatus is connected to the recording apparatus to dishonestly copy the disk into a new disk, but all of the data containing the electronic watermark data cannot be copied. As a result, a reproducing apparatus which can realize the easy and strong copy protection by use of the error correction function can be provided.

[0020] This summary of the invention does not necessarily describe all necessary features so that the invention may also be a sub-combination of these described features.

[0021] The invention can be more fully under stood from the following detailed description when taken in conjunction with the accompanying drawings, in which:

FIG. 1A is a perspective view for illustrating the structure of a variably recordable optical disk used in a DVD digital video recorder;

FIG. 1B is a diagram showing an ECC block containing electronic watermark data therein according to one embodiment of this invention;

FIG. 2 is a flowchart for illustrating one example of a method for recording data containing an electronic watermark according to one embodiment of this invention;

FIG. 3 is a flowchart for illustrating another example of a method for recording data containing an electronic watermark according to one embodiment of this invention;

FIG. 4 is a flowchart for illustrating one example of a method for reproducing data containing an electronic watermark (password) according to one embodiment of this invention;

FIG. 5 is a block diagram showing an error correction circuit and electronic watermark data extracting section according to an embodiment of this invention;

FIG. 6 is a block diagram showing an ECC block encoding circuit and electronic watermark data inserting section according to an embodiment of this invention;

FIGS. 7A and 7B are diagrams showing the content of the electronic watermark data having a parity code attached thereto;

FIG. 8 is a diagram showing an example in which the position of electronic watermark data inserted in the ECC block according to a second embodiment of this invention is changed;

FIG. 9 is a diagram showing another example in which the position of electronic watermark data inserted in the ECC block according to a second embodiment of this invention is changed;

FIG. 10 is a diagram for illustrating a pattern (pattern A) of electronic watermark data inserted in the ECC block according to the second embodiment of this invention;

FIG. 11 is a diagram for illustrating a pattern (pattern B) of electronic watermark data inserted in the ECC block according to the second embodiment of this invention;

FIG. 12 is a diagram for illustrating a pattern (pattern C) of electronic watermark data inserted in the ECC block according to the second embodiment of this invention;

FIG. 13 is a block diagram for illustrating the construction of a disk recording/reproducing apparatus according to

an embodiment of this invention;

FIG. 14 is a diagram showing the basic relation between the hierarchical file system structure and the contents of data recorded on a data recording medium;

FIG. 15 is a diagram for illustrating the description contents of a long allocation descriptor;

FIG. 16 is a diagram for illustrating the description contents of a short allocation descriptor;

FIG. 17 is a diagram for illustrating the description contents of unallocated space entry;

FIG. 18 is a diagram for illustrating the description contents of file entry which is partly extracted;

FIG. 19 is a diagram for illustrating the description contents of a file identifier descriptor which is partly extracted;

FIG. 20 is a diagram for illustrating an example of the construction of a file system;

FIG. 21 is a first partial diagram for illustrating an example in which a file system is constructed on the data recording medium according to a universal disk format (UDF);

FIG. 22 is a second partial diagram for illustrating an example in which a file system is constructed on the data recording medium according to the UDF together with FIG. 21; and

FIG. 23 is a third partial diagram for illustrating an example in which a file system is constructed on the data recording medium according to the UDF together with FIGS. 21 and 22.

[0022] There will now be described copy protecting system using an electronic watermark according to this invention with reference to the accompanying drawings.

[0023] First, a medium and a recording/reproducing apparatus for reproducing the medium according to a first embodiment of this invention are explained in detail below.

[0024] FIG. 1A is a perspective view for illustrating the structure of a variably recordable optical disk used in a DVD digital video recorder. As shown in FIG. 1, the optical disk 10 has a structure in which a pair of transparent substrates 14 having recording layers 17 formed thereon are laminated to each other by an adhesive layer. Each of the substrates 14 can be formed of a polycarbonate film of 0.6 mm thickness and the adhesive layer 20 can be formed of an extremely thin (for example, 40 thick) ultraviolet curing resin. The large-capacity optical disk 10 of 1.2 mm thickness can be obtained by laminating the pair of substrates 14 of 0.6 mm thickness with the recording layers 17 set in contact with the surfaces of the adhesive layer 20.

[0025] The recording layers 17 can be formed to have a ROM/RAM two-layered structure. In this case, a RAM layer/phase variation recording layer 17B is formed in a far-distant position as viewed from a readout surface 19.

[0026] A central hole 22 is formed in the optical disk 10 and a clamp area 24 for clamping the optical disk 10 at the time of rotation driving is formed around the central hole 22 on each surface of the disk. In the central hole 22, a spindle of a disk motor is inserted when the optical disk 10 is loaded on a disk driving device (not shown). The optical disk 10 is clamped during the rotation in the clamp area 24 by use of a disk clamper (not shown).

[0027] The optical disk 10 has a data area 25 in which video data, audio data and other data can be recorded around the clamp area 24.

[0028] A lead-out area 26 is formed on the outer peripheral side of the data area 25. Further, a lead-in area 27 is formed on the inner peripheral side around the clamp area 24. A data recording area 28 is defined between the lead-out area 26 and the lead-in area 27.

[0029] For example, a recording track is continuously formed in a spiral form on the recording layer (light reflection layer) 17 of the data area 25. The continuous track is divided into a plurality of physical sectors and consecutive numbers are attached to the sectors. Various data is recorded on the optical disk 10 by using the sector as a recording unit.

[0030] The data recording area 28 is an actual data recording area and video data (main video data), sub-video data such as a caption and menu and audio data such as a speech and sound effect of a movie or the like are recorded as recording/reproducing data in the form of pit string (phase status or physical shape which causes an optical variation in the laser reflection light).

[0031] If the optical disk 10 is a double-face recording RAM disk with each surface formed of a single layer, each of the recording layers 17 can be formed of a three-layered structure in which a phase variation recording material layer (for example, $Ge_2Sb_2Te_5$) is held between two layers of mixtures of zinc sulfide and silicon oxide ($ZnS\ SiO_2$).

[0032] If the optical disk 10 is a single-face recording RAM disk with each surface formed of a single layer, the recording layer 17 on the readout surface 19 side can be formed of a three-layered structure containing the above phase variation recording material layer. In this case, the layer 17 located far apart as viewed from the readout surface 19 is not necessarily a data recording layer and may be a dummy layer.

[0033] If the optical disk 10 is a single-face reading type two-layered RAM/ROM disk, the two recording layers 17 can be formed of a phase variation recording layer (in a far-distant position as viewed from the readout surface 19; reading/writing) and a semi-transparent metal reflection layer (in a nearer position as viewed from the readout surface 19; reproducing only).

[0034] If the optical disk 10 is a write once DVD-R, polycarbonate can be used for the substrate, gold can be used for a reflection film (not shown) and ultraviolet curing resin can be used for a protection film (not shown). In this case, an

organic coloring matter is used for the recording layer 17. As the organic coloring matter, cyanin, squalelium, clokonick, triphenylmenthane-series coloring matter, xanthene, quinone-series coloring matter (naphtoquine, anthraquine or the like), metal complex-series coloring matter (phtalocyan, porphyrin, dithiol comlex or the like) or the like can be used.

[0035] The operation of writing data into the DVD-R disk can be effected by use of semiconductor laser with the wavelength of 650 nm and output power of 6 to 12 mW.

[0036] If the optical disk 10 is a single-face reading type two-layered ROM disk, the two recording layers 17 can be formed of a metal reflection layer (in a far-distant position as viewed from the readout surface 19) and a semi-transparent metal reflection layer (in a nearer position as viewed from the readout surface 19).

[0037] In the read-only DVD-ROM disk 10, a pit string is previously formed in the substrate 14 by use of a stamper, a reflection layer such as a metal layer is formed on the surface of the substrate 14 on which the pit string is formed and the reflection layer is used as the recording layer 17. With the above DVD-ROM disk 10, generally, a groove used as the recording track is not specifically formed and the pit surface formed on the surface of the substrate 14 is used as the track.

[0038] In the various types of optical disks 10 described above, ROM data of reproducing-only is recorded on the recording layer 17 as an emboss signal. In contrast, such an emboss signal is not formed in the substrate 14 having the reading/writing (or write once) type recording layer 17, but a continuous groove is formed instead thereof. A phase variation recording layer is formed in the groove. In the case of a reading/writing type DVD-RAM disk, a phase variation recording layer on the land portion in addition to the groove portion is used for data recording.

[0039] If the optical disk 10 is a single-face reading type (irrespective of whether the recording layer is a single-layered type or double-layered type), the substrate 14 which is on the rear surface side as viewed from the readout surface 19 is not necessarily transparent with respect to the reading/writing laser beam. In this case, a label printing may be made on the whole surface of the rear side substrate 14.

[0040] A DVD digital video recorder which will be described later is so constructed that the repetitive recording/repetitive reproducing (reading/writing) operation for the DVD-RAM disk (or DVD-RW disk), the one time recording/repetitive reproducing operation for the DVD-R disk, and the repetitive reproducing operation for the DVD-ROM disk can be effected.

[0041] Electronic watermark data according to this invention is stored into a preset area in the above-described medium.

[0042] FIG. 1B is a diagram showing an ECC block containing electronic watermark data therein according to one embodiment of this invention. In this case, an example of one ECC block structure is shown when data is recorded as the ECC block used as one unit on a reproducing-only data recording medium such as a DVD-ROM or DVD video.

[0043] An error correction code (ECC code) called an inner parity code (PI) is attached in a column direction 4 to data recorded in an original signal field 11 before an error correction code is attached. The code is arranged in a PI field 12 in FIG. 1. Further, at this time, an error correction code (ECC code) called an outer parity code (PO) is calculated and arranged in a PC field 13.

[0044] In this state, electronic watermark data items of a to p (a to p is 1-bit data of "1" or "0") are inserted in preset positions in a preset sequence in an overwriting manner. Then, the data is recorded on the rewritable data recording medium such as a DVD-RAM with the configuration of FIG. 1 kept unchanged.

[0045] When data is reproduced from the data recording medium, electronic watermark data is read out by extracting data items a to p from the preset position according to the predetermined sequence. If the thus readout electronic watermark data coincides with collation data, data recorded on the data recording medium is determined as original data (data which is not dishonestly copied).

[0046] Electronic watermark data of a to p in FIG. 1 is regarded as intentionally added defective data as viewed from the outer parity code or inner parity code in the ECC block. Therefore, when data shown in FIG. 1 is reproduced, the defective data (electronic watermark data) of a to p is corrected by the error correction process. Thus, an original signal (corresponding to data having the contents required to be prevented from being dishonestly copied) before the electronic watermark data is inserted can be obtained.

[0047] Now, consider a case wherein a dishonest third party dishonestly copies data from which the electronic watermark data is eliminated by the error correction process on a digital recordable data recording medium such as a DVD-RAM o r DVD-R. In this case, only data (containing no electronic watermark data) obtained after the error correction process is transferred to and copied in a disk at the dishonest copy destination. That is, data from which the electronic watermark data is eliminated by the error correction function is copied in the dishonest copy destination.

[0048] When data dishonestly copied on the data recording medium is reproduced by a reproducing apparatus, no electronic watermark data can be detected even if the electronic watermark data of a to p is searched for. In this case, the data recording medium is determined as a dishonestly copied medium, and alarm display indicating the dishonest copy is made and the reproducing process is interrupted.

[0049] If the data amount of the electronic watermark data (a to p) of FIG. 1 increases, the error correction ability is exceeded and there occurs a possibility that data before the electronic watermark data is added cannot be reproduced.

That is, the data amount of the electronic watermark data which can be added for each ECC block has an upper limit. The upper limit value is preferably set to approx. 1/10000 or less of the whole data amount constructing one ECC block as a value determined by taking a certain amount of margin with respect to the error correction ability into consideration when a product code is used for the error correction system.

[0050] As a concrete example, in the DVD standard utilizing the product code in the error correction system, it is preferable to set the amount of electronic watermark data for one ECC block to approx. 3 bytes or less since the whole data amount for one ECC block is approx. 32 kilo-bytes. That is, it is preferable to express the electronic watermark data by a combination of one-bit codes using up to 24 to 26 bits in total.

[0051] In a product code ECC block of 32 kilo-byte unit used in the DVD, the error correction for an error up to 5 bits for one column in the column direction 4 in FIG. 1 can be made. Likewise, the error correction for an error up to 5 bits for one row in the row direction 5 can be made. Therefore, electronic watermark data of 5 bits at maximum for each column or row can be inserted.

[0052] However, in order to make it possible to effect the error correction process even if a large amount of errors due to defects on the data recording medium occur, it becomes necessary to distribute and insert the electronic watermark data into the ECC block so that the electronic watermark data will not be localized in a specified column or specified row. In the example of FIG. 1, the electronic watermark data is arranged in a staggered form so as to set the amount of the electronic watermark data for one column (or one row) to one bit or less.

[0053] The explanation made so far is a basic explanation for a case wherein data having the structure of FIG. 1 is previously recorded on the reproducing-only data recording medium (such as a DVD-ROM). The basic explanation can also be applied to a recordable data recording medium (such as a DVD-RAM).

[0054] The construction of a disk recording/reproducing apparatus is explained before the method for recording data on the recordable recording medium by the user is explained.

[0055] The disk recording/reproducing apparatus is roughly divided into a disk recording/reproducing section (physical series block) for recording and reproducing data with respect to the data recording medium and an application constructing section (application block) constructed by a function performing section for performing independent apparatus functions as the disk recording/reproducing apparatus and an interface section with respect to the exterior.

[0056] First, the internal construction of the disk recording/reproducing section (physical series block) in the disk recording/reproducing apparatus is explained with reference to FIG. 13.

〈〈〈 Function Explanation of Disk Recording/Reproducing Section 〉〉〉

〈〈 Basic Function of Disk Recording/Reproducing Section 〉〉

[0057] In the disk recording/reproducing section, new data is recorded or rewritten (including deletion of data) in a preset position on a data recording medium (optical disk) 201 by use of a convergent light spot of laser beam.

[0058] Data which is already recorded is reproduced from a preset position on the data recording medium (optical disk) 201 by use of a convergent light spot of laser beam.

〈〈 Basic Function Performing Means of Disk Recording/Reproducing Section 〉〉

[0059] In order to attain the basic function, a convergent light spot is traced (followed) along a track (not shown) on the data recording medium 201 in the disk recording/reproducing section. The data recording/reproducing/deleting operations are switched by changing the light amount (strength) of the convergent light spot applied to the data recording medium 201. A recorded signal Sd supplied from the exterior is converted into an optimum signal so that the signal can be recorded at high density and low error rate.

〈〈〈 Structure of Mechanism Section and Operation of Detecting Section 〉〉〉

〈〈 Basic Structure of Optical Head 202 and Signal Detecting Circuit 〉〉

〈Signal Detection by Optical Head 202〉

[0060] The optical head 202 is basically constructed by a semiconductor laser element (not shown) which is a light source, photodetector and object glass.

[0061] Laser light emitted from the semiconductor laser element is converged on the data recording medium (optical disk) 201 by the object glass. Laser light reflected from a light reflection film or light reflective recording film of the data recording medium (optical disk) 201 is photoelectrically converted by the photodetector.

[0062] A detected current obtained in the photodetector is subjected to the current-voltage conversion by an amplifier

213 and is used as a detection signal. The detection signal is processed by a focus track error detecting circuit 217 or binarizing circuit 212.

[0063] Generally, the photodetector is divided into a plurality of light detecting areas to individually detect variations in the amounts of light applied to the respective light detecting areas. The calculations of addition and subtraction are performed for the individual detection signals in the focus track error detection circuit 217 to detect focus deviation and track deviation. After the detected focus deviation and track deviation are substantially eliminated, a variation in the amount of reflected light from the light reflection film or light reflective recording film of the data recording medium (optical disk) 201 is detected and a signal on the data recording medium 201 is reproduced.

〈Focus Deviation Detecting Method〉

[0064] As a method for optically detecting the focus deviation amount, the following methods are provided, for example.

[Astigmatism Method]

[0065] This method is to arrange an optical element (not shown) which causes astigmatism in the detection optical path of laser light reflected light from the light reflection film or light reflective recording film of the data recording medium (optical disk) 201 and detect a variation in the shape of the laser light applied to the photodetector. The light detecting area is divided into four areas by the diagonal lines. A difference between two added detection signals for the diagonal positions among the detection signals derived from the light detecting areas is derived by the focus track error detecting circuit 217 to obtain a focus error detection signal.

[Knife-Edge Method]

[0066] This method is to arrange a knife edge which asymmetrically shields part of laser light reflected from the data recording medium 201. The light detecting area is divided into two areas and a difference between the detection signals derived from the detection areas is derived to obtain a focus error detection signal.

[0067] Generally, one of the astigmatism method and knife-edge method is used.

〈Track Deviation Detecting Method〉

[0068] The data recording medium 201 has a spiral-form track or concentric tracks and data is recorded on the track. A convergent light spot is traced along the track to reproduce or record/delete data. In order to stably trace the convergent light spot along the track, it is necessary to optically detect the relative positional deviation between the track and the convergent light spot.

[0069] As the track deviation detecting method, the following methods are generally used.

[Differential Phase Detection Method]

[0070] This method is to detect a variation in the strength distribution on the photodetector of laser light reflected from the light reflection film or light reflective recording film of the data recording medium (optical disk) 201. The light detecting area is divided into four areas by the diagonal lines. A difference between added detection signals for the diagonal positions among the detection signals derived from the light detecting areas is derived by the focus track error detecting circuit 217 to obtain a track error detection signal.

[Push-Pull Method]

[0071] This method is to detect a variation in the strength distribution on the photodetector of laser light reflected from the data recording medium 201. The light detecting area is divided into two areas and a difference between the detection signals derived from the detection areas is derived to obtain a track error detection signal.

[Twin-Spot Method]

[0072] This method is to arrange a diffracting element or the like in a light transmission system between the semiconductor laser element and the data recording medium 201 to divide light into a plurality of wave fronts and detect a variation in the amount of reflected light of 7 primary diffraction light applied to the data recording medium 201. A light detection area for individually detecting variations in the amounts of reflection light of +primary diffraction light and -pri-

mary diffraction light is arranged separately from the light detection area for detecting the reproduced signal and a difference between the detection signals is derived to obtain a track error detection signal.

⟨Object Glass Actuator Structure⟩

[0073] An object glass (not shown) for converging laser light emitted from the semiconductor laser element on the data recording medium 201 is so constructed as to move in two-axial directions according to an output current of the object glass actuator driving circuit 218. Two moving directions of the object glass are as follows. That is, the object glass moves in a vertical direction with respect to the data recording medium 201 for correction of the focus deviation and moves in a radial direction of the data recording medium 201 for correction of the track deviation.

[0074] A moving mechanism (not shown) of the object glass is called an object glass actuator. As the object glass actuator structure, the following structures are often used, for example.

[Axial Sliding System]

[0075] This system is a system in which a blade integrally formed with the object glass is moved along the central axis (shaft), the blade is moved in a direction along the central axis to correct the focus deviation and the blade is rotated with the central axis set as a center to correct the track deviation.

[Four Wire System]

[0076] This system is a system in which a blade integrally formed with the object glass is connected to a fixed system via four wires and the blade is moved in two axial directions by use of elastic deformation of the wires.

[0077] In each of the above systems, a permanent magnet and a coil are used and the blade is moved by passing a current in the coil connected to the blade.

⟨⟨Rotation Control System of Data Recording Medium 201⟩⟩

[0078] The data recording medium (optical disk) 201 is loaded on a rotation table 221 which is rotated by driving force of a spindle motor 204.

[0079] The rotation speed of the data recording medium 201 is detected by a reproduced signal obtained from the data recording medium 201. That is, the detection signal (analog signal) output from the amplifier 213 is converted into a digital signal by the binarizing circuit 212 and a signal of constant period (reference clock signal) is generated from a PLL circuit 211 based on the above digital signal. A data recording medium rotation speed detecting circuit 214 detects the rotation speed of the data recording medium 201 by use of the above signal and outputs the value thereof.

[0080] A correspondence table of the data recording medium rotation speed corresponding to the radial position in which the reproducing operation or the recording/deleting operation is effected on the data recording medium 201 is previously recorded in a semiconductor memory 219. If the reproducing position or the recording/deleting position is determined, a controller section 220 refers to data of the semiconductor memory 219 to set a target rotation speed of the data recording medium 201 and notifies the value to a spindle motor driving circuit 215.

[0081] In the spindle motor driving circuit 215, a difference between the target rotation speed and an output signal (present rotation speed) of the data recording medium rotation speed detecting circuit 214 is derived and a driving current corresponding to the derived difference is supplied to the spindle motor 204 to control the rotation speed of the spindle motor 204 to a constant value. The output signal of the data recording medium rotation speed detecting circuit 214 is a pulse signal having a frequency corresponding to the rotation speed of the data recording medium 201 and both of the frequency and pulse phase of the pulse signal are controlled (frequency control and phase control) in the spindle motor driving circuit 215.

⟨⟨Optical Head Moving Mechanism⟩⟩

[0082] The mechanism has an optical head moving mechanism (forwarding motor) 203 for moving an optical head 202 in the radial direction of the data recording medium 201.

[0083] As a guide mechanism for moving the optical head 202, a rod-like guide shaft is used in many cases. In the guide mechanism, the optical head 202 is moved by use of friction between the guide shaft and the bush attached to part of the optical head 202. Further, a method using a bearing which reduces the friction force by use of the rotation movement is provided.

[0084] Although not shown in the drawing, the driving force transmission method for moving the optical head 202 can be attained by arranging a rotation motor with a pinion (rotation gear) on the fixed system, arranging a rack which is a

linear gear and engages with the pinion on the side surface of the optical head 202 and converting the rotation movement of the rotation motor into the linear movement of the optical head 202. As the other driving force transmission method, a linear motor system for arranging a permanent magnet on the fixed system and passing a current in the coil disposed on the optical head 202 to linearly move the same in a certain direction may be used in some cases.

[0085] In either method using the rotation motor or linear motor, basically, the driving force for moving the optical head 202 is generated by passing a current in the forwarding motor. The driving current is supplied from a motor driving circuit 216.

〈〈〈 Functions of Various Control Circuits 〉〉〉

〈〈 Convergent Light Spot Tracing Control 〉〉

[0086] A circuit for supplying a driving current to an object glass actuator (not shown) in the optical head 202 according to an output signal (detection signal) of the focus track error detection circuit 217 to correct the focus deviation or track deviation is the object glass actuator driving circuit 218. The driving circuit 218 contains a phase compensation circuit for improving the characteristic in accordance with the frequency characteristic of the object glass actuator in order to make the object glass movement responsive at high speed up to the high frequency range.

[0087] In the object glass actuator driving circuit 218, the following processes are effected in response to an instruction from the controller section 220.

(a) The ON/OFF process of the focus/track deviation correcting operation (focus/track loop)
(b) The process (effected at the OFF time of the focus/track loop) for moving the object glass in the vertical direction (focus direction) of the data recording medium 201 at low speed
(c) The process for slightly moving the object glass in the radial direction (in a direction across the track) of the data recording medium 201 by use of a kick pulse to move the convergent light spot to the adjacent track.

〈〈 Laser Light Amount Control 〉〉

〈Switching Operation between Reproducing Process and Recording/Deleting Process〉

[0088] The operation of switching between the reproducing process and the recording/deleting process is effected by changing the light amount of the convergent light spot applied on the data recording medium 201.

[0089] Generally, the following expression (1) holds for the data recording medium using the phase variation system.

$$[\text{light amount at recording time}] > [\text{light amount at deleting time}] > [\text{light amount at reproducing time}] \quad (1)$$

[0090] The following expression (2) generally holds for the data recording medium using the photo-electromagnetic system.

$$[\text{light amount at recording time}] \fallingdotseq [\text{light amount at deleting time}] > [\text{light amount at reproducing time}] \quad (2).$$

[0091] In the case of photo-electromagnetic system, the recording and deleting processes are controlled by changing the polarity of the external magnetic field (not shown) applied to the data recording medium 201 at the recording/deleting time.

[0092] At the data reproducing time, a constant amount of light is continuously applied to the data recording medium 201.

[0093] When new data is recorded, an amount of intermittent pulse-like light is superposed on the light amount applied at the reproducing time. When the semiconductor laser element emits a pulse with a large amount of light, the light reflective recording film of the data recording medium 201 locally causes an optical variation or a variation in the shape to form a recording mark. Also, when data is overwritten on the area in which data is already recorded, a pulse is emitted from the semiconductor laser element.

[0094] Data which is already written is deleted, a constant amount of light larger than that applied at the reproducing time is continuously applied. When data is continuously deleted, the amount of applied light is returned to that of the reproducing time for each specified period, for example, for each sector unit to intermittently reproduce data in parallel with the deleting process. Thus, the deleting process is effected while confirming that the deleting track is not erroneous by intermittently reproducing the track number and address of the track to be deleted.

⟨Laser Light Emission Control⟩

[0095] Although not shown in the drawing, a photodetector for detecting the emission light amount of the semiconductor laser element is contained in the optical head 202. In the semiconductor laser driving circuit 205, a difference between the photodetector output (the detection signal of emission light amount of the semiconductor laser element) and an emission light reference signal supplied from a record/reproduce/delete control phase generating circuit 206 is derived and the feedback control of the driving current to the semiconductor laser is effected based on the derived difference.

⟨⟨⟨ Various Operations Relating to Control System of Mechanical Portion⟩⟩⟩

⟨⟨ Start Control⟩⟩

[0096] When the data recording medium (optical disk) 201 is loaded on the rotation table 221 and the start control is started, the process according to the following procedure is effected.

(1) A target rotation speed is notified from the controller section 220 to the spindle motor driving circuit 215 and a driving current is supplied from the spindle motor 215 to the spindle motor 204 so that the spindle motor 204 will start to rotate.
(2) At the same time, a command (execution instruction) is issued from the controller section 220 to the forwarding motor driving circuit 216 and a driving current is supplied from the forwarding motor driving circuit 216 to the optical head driving mechanism (forwarding motor) 203 so as to move the optical head 202 to the innermost position of the data recording medium 201. As a result, it is confirmed that the optical head 202 lies on the inner portion located inwardly from the area in which data of the data recording medium 201 is recorded.
(3) When the rotation speed of the spindle motor 204 reaches the target rotation speed, the status (status report) is issued to the controller section 220.
(4) A current is supplied from the semiconductor laser driving circuit 205 to the semiconductor laser element in the optical head 202 in accordance with the reproducing light amount signal supplied from the controller section 220 to the record/reproduce/delete control phase generating circuit 206 to start the laser light emission process.
The optimum application light amounts differ depending on the types of the data recording media (optical disks) 201. At the starting time, a current supplied to the semiconductor laser element is set to a value corresponding to the smallest one of the application light amounts.
(5) The object glass (not shown) in the optical head 202 is set in the farthest position from the data recording medium 201 according to the command from the controller section 220 and then the object glass actuator driving circuit 218 controls the object glass so as to slowly move the object glass towards the data recording medium 201.
(6) At the same time, the focus deviation amount is monitored in the focus track error detection circuit 217, and when the object glass comes near a focused position, the status is issued to notify to the controller section 220 that "the object glass comes near the focused position".
(7) If the controller section 220 receives the status, it issues a command to the object glass actuator driving circuit 218 so as to set the focus loop ON.
(8) The controller section 220 issues a command to the forwarding motor driving circuit 216 with the focus loop kept ON so as to slowly move the optical head 202 in the outer peripheral direction of the data recording medium 201.
(9) At the same time, a reproduced signal from the optical head 202 is monitored, and when the optical head 202 comes to the recording area of the data recording medium 201, the movement of the optical head 202 is stopped and it issues a command to the object glass actuator driving circuit 218 so as to set the track loop ON.
(10) Then, "the optimum light amount at the reproducing time" and "the optimum light amount at the recording/deleting time" recorded in the inner portion of the data recording medium (optical disk) 201 are reproduced and the data items are stored into the semiconductor memory 219 via the controller section 220.
(11) Further, in the controller section 220, a signal corresponding to "the optimum light amount at the reproducing time" is supplied to the record/reproduce/delete control phase generating circuit 206 so as to set the light emission amount of the semiconductor laser element at the reproducing time again.
(12) Then, the light emission amount of the semiconductor laser element at the recording/deleting time is set according to "the optimum light amount at the recording/deleting time" recorded in the data recording medium 201.

⟨⟨ Access Control⟩⟩

[0097] Data indicating the location of the reproducing data recording medium 201 in which access destination data recorded on the data recording medium 201 is recorded and indicating the contents thereof is different depending on

the type of the data recording medium 201. For example, in a DVD disk, the data is recorded in the navigation pack or the directory management area of the data recording medium 201.

[0098] Generally, the directory management area is collectively recorded in the inner peripheral area or outer peripheral area of the data recording medium 201. Further, the navigation pack is contained in a data unit which is a VOBU (Video Object Unit) in a VOBS (Video Object Set) corresponding to the data structure of PS (Program Stream) of MPEG and data indicating the recording location of a next video image is recorded therein.

[0099] When specified data is reproduced or recorded/deleted, data in the above area is first reproduced and the access destination is determined based on the data thus obtained.

〈Rough Access Control〉

[0100] The radial position of the access destination is derived by calculations in the controller section 220 to derive a distance with respect to the present position of the optical head 202.

[0101] Speed curve data for permitting the optical head 202 to travel the distance in the shortest time is previously stored in the semiconductor memory 219. The controller section 220 reads out the data and controls the movement of the optical head 202 in the following manner according to the speed curve.

[0102] That is, the controller section 220 issues a command to the object glass actuator driving circuit 218 to set the track loop OFF and then controls the forwarding motor driving circuit 216 to start the movement of the optical head 202.

[0103] When the convergent light spot crosses the track on the data recording medium 201, a track error detection signal is generated in the focus track error detecting circuit 217. The relative speed of the convergent light spot with respect to the data recording medium 201 can be detected by use of the track error detection signal.

[0104] In the forwarding motor driving circuit 216, a difference between the relative speed of the convergent light spot obtained from the focus track error detecting circuit 217 and the target speed data sequentially supplied from the controller section 220 is derived and it moves the optical head 202 while effecting the feedback control on a driving current which is supplied to the optical head driving mechanism (forwarding motor) 203 based on the derived difference.

[0105] As described in the item 《Optical Head Moving Mechanism 》, friction force always acts between the guide shaft and the bush or bearing. Dynamical friction acts while the optical head 202 moves at high speed, but static friction occurs at the time of starting of the movement or immediately before stoppage since the optical head 202 moves slowly. When the static friction occurs (particularly, immediately before stoppage), the friction force relatively increases. In order to cope with an increases in the friction force, the amplification factor (gain) of the control system is increased by a command from the controller section 220 to increase a current supplied to the optical head driving mechanism (forwarding motor) 203.

〈Fine Access Control〉

[0106] When the optical head 202 reaches the target position, the controller section 220 issues a command to the object glass driving circuit 218 to set the track loop ON.

[0107] The convergent light spot is traced along the track on the data recording medium 201 to reproduce the address or track number of the traced portion.

[0108] The present position of the convergent light spot is derived based on the address or track number of the traced portion, the number of tracks different from the target position is calculated by the controller section 220 and the number of tracks necessary for movement of the convergent light spot is notified to the object glass actuator driving circuit 218.

[0109] If one set of kick pulses are generated in the object glass actuator driving circuit 218, the object glass slightly moves in the radial direction of the data recording medium 201 and the convergent light spot moves to the adjacent track.

[0110] In the object glass actuator driving circuit 218, the track loop is temporarily set OFF, kick pulses of a number corresponding to data from the controller section 220 are generated and then the track loop is set ON again.

[0111] After completion of the fine access control, the controller section 220 reproduces data (address or track number) in a position traced by the convergent light spot and confirms that the target track is being accessed.

《Continuous Recording/Reproducing/Deleting Control》

[0112] As shown in FIG. 13, a track error detection signal output from the focus track error detecting circuit 217 is input to the forwarding motor driving circuit 216. At the "starting control time" and "access control time" described above, the controller section 220 controls the forwarding motor driving circuit 216 so as not to use the track error detection signal.

[0113] After it is confirmed that the convergent light spot reaches the target track by the access, part of the track error detection signal is supplied as a driving current to the optical head driving mechanism (forwarding motor) 203 via the

motor driving circuit 216 according to a command from the controller section 220. In a period during which the reproduction or recording/deleting process is continuously effected, the above control operation is continuously effected.

[0114] The data recording medium 201 is mounted on the rotation table 221 with the central position thereof slightly eccentrically set with respect to the central position of the rotation table 221. When part of the track error detection signal is supplied as the driving current, the whole portion of the optical head 202 slightly vibrates according to the eccentricity.

[0115] Further, if the reproduction or recording/deleting process is continuously effected for a long time, the convergent light spot gradually moves in the outer or inner peripheral direction. When part of the track error detection signal is supplied as a driving current to the optical head moving mechanism (forwarding motor) 203, the optical head 202 gradually moves in the outer or inner peripheral direction accordingly.

[0116] Thus, the track loop can be stabilized by alleviating the load due to track deviation correction of the object glass actuator.

⟨⟨Termination Control⟩⟩

[0117] When a sequence of processes are completed and the operation is terminated, the process is effected according to the following procedure.

(1) A command for setting the track loop OFF is issued from the controller section 220 to the object glass actuator driving circuit 218.
(2) A command for setting the focus loop OFF is issued from the controller section 220 to the object glass actuator driving circuit 218.
(3) A command for terminating the light emission operation of the semiconductor laser element is issued from the controller section 220 to the record/reproduce/delete control phase generating circuit 206.
(4) "0" is notified as a reference rotation speed to the spindle motor driving circuit 215.

⟨⟨⟨Flow of Recording Signal/Reproducing Signal to Data Recording Medium⟩⟩⟩

⟨⟨Flow of Signal at Reproducing Time⟩⟩

⟨Binary-Coding/PLL Circuit⟩

[0118] As described in the item ⟨Signal Detection by Optical Head 202⟩ a variation in the amount of reflected light from the light reflection film or light reflective recording film of the data recording medium (optical disk) 201 is detected to reproduce a signal on the data recording medium 201. A signal obtained by the amplifier 213 has an analog waveform. The binarizing circuit 212 uses a comparator to convert the analog signal to a binary digital signal of "1" and "0".

[0119] A reference signal at the time of data reproduction is derived from the reproduced signal obtained by the binarizing circuit 212 in the PLL circuit 211. That is, the PLL circuit 211 contains a frequency variable oscillator and compares the frequencies and phases between the pulse signal (reference clock) output from the oscillator and the output signal of the binarizing circuit 212. The result of comparison is fed back to the oscillator output so as to produce a reference signal at the time of data reproduction.

⟨Demodulation of Signal⟩

[0120] A demodulation circuit 210 contains a conversion table indicating the relation between the modulated signal and the signal obtained after demodulation. The demodulation circuit 210 restores an input signal (modulated signal) into an original signal (demodulated signal) while referring to the conversion table according to the reference clock obtained in the PLL circuit 211.

[0121] The demodulated signal is stored into the semiconductor memory 219 via a signal line (a signal line directly connecting the demodulation circuit 210 to the bus line 224) on the leftmost position in FIG. 5.

⟨Error Correction Process⟩

[0122] The internal construction of an error correction circuit 209 is as shown in FIG. 5. That is, the interior of the error correction circuit 209 is roughly divided into an ECC block error correction processing section 225 and an electronic watermark data extracting section 229. Further, the electronic watermark extracting section 229 includes an address extracting section 226 for watermark data in an ECC block, temporary storage section 227 for electronic watermark matrix data, and electronic watermark data error correction section 228.

[0123] In the ECC block error correction processing section 225, an error position is detected for a signal stored in the semiconductor memory 219 by use of the inner parity code PI and outer parity code PO and a pointer flag of the error position is set. After this, a signal in the error position is sequentially corrected according to the error pointer flag while reading out a signal from the semiconductor memory 219 and then corrected data is stored into the semiconductor memory 219 again.

[0124] In a case where data reproduced from the data recording medium 201 is output to the exterior as a reproduced signal Sc shown in FIG. 13, the inner parity code PI and outer parity code PO are eliminated from error corrected data stored in the semiconductor memory 219, and the thus obtained data is transferred to a data input/output interface section 222 via the bus line 224.

[0125] Then, the data input/output interface section 222 outputs a signal supplied from the error correction circuit 209 as the reproduced signal Sc.

⟨⟨ Signal Format Recorded on Data Recording Medium 201 ⟩⟩

[0126] A signal recorded on the data recording medium 201 is required to satisfy the following requirements.

(a) Recorded data error caused by the defect on the data recording medium 201 can be corrected.
(b) A DC component of the reproduced signal is set to "0" to simplify the reproduction processing circuit.
(c) Data can be recorded on the data recording medium 201 with maximum permissible density.

[0127] In order to satisfy the above requirements, "addition of the error correction function" and "signal conversion (signal modulation/demodulation) for recorded data" are effected in the disk recording/reproducing section (physical series block) shown in FIG. 13.

⟨⟨ Signal Flow at Recording Time ⟩⟩

⟨Error Correction Code ECC Adding Process⟩

[0128] The error correction code ECC (Error Correction Code) adding process is explained with reference to FIG. 6.

[0129] The internal construction of an ECC encoding circuit 208 is as shown in FIG. 6. That is, the ECC encoding circuit 208 includes an ECC block encoding circuit 208A and an electronic watermark data inserting section 233. Further, the electronic watermark data inserting section 233 includes an inserting address designating section 230 for watermark data in an ECC block, an electronic watermark matrix data temporary storage section 231 and a calculation section 232 for PI data and PO data of watermark data.

[0130] Data which is desired to be recorded on the data recording medium 201 is input to the data input/output interface section 222 of FIG. 13 as a recorded signal Sd in the form of original signal. The recorded signal Sd is stored in the semiconductor memory 219 of FIG. 6 as it is. After this, the following ECC adding process is effected in the ECC block encoding circuit 208A of the ECC encoding circuit 208.

[0131] A concrete example of the ECC adding method using a product code is explained below.

[0132] The recorded signal Sd is sequentially arranged for every 172 bytes for each column in the semiconductor memory 219 and one ECC block is formed of 192 columns (a data amount of approx. 32 kilo-bytes can be obtained by 172 bytes (for each column) × 192 bytes (for each row)).

[0133] An inner parity code PI of 10 bytes is calculated for each column of 172 bytes is calculated for the original signal (recorded signal Sd) in one ECC block constructed by "172 bytes (for each column) × 192 bytes (for each row)" and additionally stored into the semiconductor memory 219. Further, an outer parity code PO of 16 bytes is calculated for each row in the byte unit and additionally stored into the semiconductor memory 219.

[0134] The total of 2366 bytes (= (12+1) × (172+10)) of 12 columns (12 × (172+10) bytes) including the inner parity code PI of 10 bytes and one column (1 × (172+10) bytes) of the outer parity code PO is used as a unit and data subjected to the error correction code ECC adding process is recorded in one sector of the data recording medium 201.

[0135] The ECC block encoding circuit 208A of the ECC encoding circuit 208 transfers data to the semiconductor memory 219 when addition of the inner parity code Pi and outer parity code PO is completed.

[0136] When data is recorded on the data recording medium 201, a signal of every 2366 bytes of one sector is transferred from the semiconductor memory 219 to the modulation circuit 207 via the signal line (shown on the left side in FIG. 6) directly connecting the bus line 224 to the modulation circuit 207.

⟨Signal Modulation⟩

[0137] The signal modulation which is the conversion of the signal format is effected in the modulation circuit 207 to

set a DC component (DSV : Digital Sum Value or Digital Sum Variation) of the reproduced signal closer to "0" and record data on the data recording medium 201 at high density.

[0138] The modulating circuit 207 and demodulating circuit 210 of FIG. 13 respectively contain conversion tables indicating the relation between an original signal and a signal obtained after modulation. The modulating circuit 207 divides a signal transferred from the ECC encoding circuit 208 into portions of a plurality of bits according to a preset modulation system and converts the signal into another signal (code) while referring to the conversion table.

[0139] In a case where 8/16 modulation (RLL(2, 10) code) is used as the modulation system, for example, two types of conversion tables are provided and a reference conversion table is selectively used to set the DC component (DSV) obtained after modulation closer to "0".

(Recording Waveform Generation)

[0140] When a recording mark is recorded on the data recording medium (optical disk) 201, generally, the following systems are provided as the recording system.

[Mark Length Recording System] "1" comes in the front and rear end positions of the recording mark.
[Intra-Mark Recording System] The central position of the recording mark coincides with the position of "1".

[0141] If the mark length recording system is used, it is necessary to form a relatively long recording mark. In this case, if recording light of a large amount is continuously applied to the data recording medium 201 for a preset period of time or more, the width of only the rear portion of the mark is made larger due to the heat storage effect of the light reflective recording film of the data recording medium 201 and a recording mark in the form of raindrop is formed. In order to solve this problem, the recording laser driving signal is divided into a plurality of recording pulses or the recording waveform of the recording laser is changed in a stepwise form when a long recording mark is formed.

[0142] In the record/reproduce/delete control phase generating circuit 206, a recording waveform is formed according to the recording signal supplied from the modulating circuit 207 and a driving signal having the thus formed recording waveform is supplied to the semiconductor laser driving circuit 205.

(Insertion of Electronic Watermark Data)

[0143] FIGS. 7A and 7B are diagrams showing the contents of electronic watermark data to which a parity code is added. In this case, an example of a method for inserting the electronic watermark data using a user password is explained.

[0144] An example of password data registered by the user and stored in the semiconductor memory 219 is shown in FIG. 7A.

[0145] Each of data items a to i in FIG. 7A indicates bit data of "0" or "1". The electronic watermark matrix data temporary storage section 231 shown in FIG. 6 reads out user password data stored in the semiconductor memory 219 and rearranges the one-dimensional password a to i of FIG. 7A into a two-dimensional matrix as shown in FIG. 7B.

[0146] In the calculation section 232 for PI data and PO data of watermark data of FIG. 6, a PI (Inner Parity Code: error correction inner parity code) 6 and PO (Outer Parity Code: error correction outer parity code) 7 are calculated and added to user password data two-dimensionally arranged as shown in FIG. 7B. Thus, bit data items a to p which are completed by adding the error correction inner parity code (j, k, 1) 6 and outer parity code (m, n, o, p) 7 are used as the electronic watermark data.

[0147] In order to insert the electronic watermark data into the specified position as shown in FIG. 1, the inserting address designating section 230 for watermark data in the ECC block specifies the inserting position of the electronic watermark data and sequentially inserts the electronic watermark data bits of a to p into the ECC block data stored in the semiconductor memory 219.

[0148] In the ECC encoding circuit 208 shown in FIG. 6, a method for overwriting the electronic watermark data on the ECC block data which is previously formed is used as a method for inserting the electronic watermark data.

[0149] As the insertion method of the electronic watermark data, a method other than the above "Overwriting" method can be used. For example, the electronic watermark data can be inserted into the ECC block data by a method using an exclusive OR circuit, for adding original ECC block data and electronic watermark data in the unit of bit. The process for inserting (overwriting) the

[0150] electronic watermark data on the ECC block (matrix) is effected in the step S120 in the flowchart of FIG. 2.

[0151] Data obtained after completion of the electronic watermark data insertion process is recorded on the data recording medium (optical disk) 201 via the bus line 224, modulation circuit 207, record/reproduce/delete control phase generating circuit 206, semiconductor laser driving circuit 205 and optical head 202.

[0152] FIG. 2 is a flowchart for illustrating an example of a method for recording data containing the electronic water-

mark according to one embodiment of this invention. A method for recording data which the user forms and which is an object of protection of copyright requiring a copy protecting process on the data recording medium is explained with reference to the flowchart. The process of the flowchart is effected by, for example, a micro-computer (CPU or MPU) contained in the controller section 220 of FIG. 13.

[0153] After the user forms data contents of file data (S101), the storage process of file data is effected (S102). As part of the storage process effected by the user, a process (S103) for designating the storage location (one of the directories under which data is stored) of file data, a process (S104) for registering the file name of the storage file and a process (S105) for registering the user password are effected. For data which requires the copy protecting process, the dishonest copy preventing process is effected by use of the registered user password.

[0154] The above sequence of processes (S106) are the operations effected on the user side. The disk recording/reproducing apparatus receives data obtained by the user operation S106 and effects the following operation (S122).

[0155] First, the password data registered by the user is stored into the semiconductor memory 219 of FIG. 13. Then, as the encrypting process of the user password, an encrypt/decrypt processing circuit 223 shown in FIG. 13 reads out the password from the semiconductor memory 219 and performs the encrypting process (S107).

[0156] The password thus encrypted is stored into the semiconductor memory 219 again. After this, the optical head moving mechanism (forwarding motor) 203 moves the optical head 202 to access the storage location (sector position on the data recording medium in which the directory is stored) designated by the user (S108).

[0157] In a case where a DVD-RAM drive is used as the disk recording/reproducing apparatus, a file format called UDF which will be described later is used for the file management. In the UDF, a file name in the file management area is recorded in a file identifier descriptor FID as will be described later.

[0158] In FIG. 2, in the FID registering process S109 to the designated directory, the encrypted user password is read out from the semiconductor memory 219 and recorded into the file identifier descriptor FID (S111) after the file name registering process S110 in the file identifier descriptor FID.

[0159] After this, file data is FE-registered (the detail of the process is described later) (S112) and then the data contents storing process of renewed file data is effected (S113).

[0160] In the data contents storing process, the storing process is effected (S113) according to the procedure described in the item (Error Correction Code ECC Adding Process). That is, the outer parity code PO calculation process (S114), inner parity code PI calculation process (S115), and the process (S116) for forming an ECC block (matrix) are effected and the results are stored in the semiconductor memory 219 (S120).

[0161] Further, if the user password is registered in the user password registering process (S105) in the user operation (S106), the process (S117) for calculating the outer parity code (PO7 in FIG. 7B) PO of the user password, the process (S118) for calculating the inner parity code (PO6 in FIG. 7B) PO of the user password and the process (S119) for forming an electronic watermark pattern (electronic watermark data a to p) corresponding to the registered user password are effected in the data contents storing process (S113).

[0162] The electronic watermark data (a to p) is inserted into the preset position shown as an example in FIG. 1 (S120). The process is the insertion (overwriting) process (S120) of electronic watermark data on the ECC block (matrix).

[0163] Thus, data in which a copy protecting password (electronic watermark data formed in the electronic watermark pattern forming process S119) is inserted into data (formed in the ECC block forming process S116) required to be protected from being dishonestly copied is recorded on the data recording medium (such as a DVD-RAM disk) 201 (S121).

[0164] FIG. 3 is a flowchart for illustrating a processing method effected in a case where file data recorded on the data recording medium 201 according to the method explained in FIG. 2 is renewed. In the user operation (S106) in FIG. 3, the same

[0165] operation as the user operation (S106) in FIG. 2 is effected except that a file data name is selected instead of specifying the file data name.

[0166] In FIG. 3, when a data renewing process is effected, the process (S111) for registering the encrypted password into the file identifier descriptor FID of FIG. 2 is not effected. That is, the password used when file data is first recorded is continuously stored in the file identifier descriptor FID.

[0167] At the time of data renewing process, since a person who renews data inputs the password, the password of a person who has renewed data is recorded in the electronic watermark data recorded according to the flowchart of FIG. 3. Therefore, if a person who first records the file data is different from a person who renews the data, the user password in the file identifier descriptor FID and the password in the electronic watermark data will become different.

[0168] At the time of reproduction of data from the data recording medium, both of the user password in the file identifier descriptor FID and the password in the electronic watermark data are read out and compared with each other, and then it is understood that a third party has renewed the file data.

[0169] The process is effected according to the procedure of FIG. 3 when file data previously formed is copied on a data recording medium.

[0170] That is, if data containing the electronic watermark data is dishonestly copied, the user password of a person who has formed original file data is recorded on the data recording medium 201 of copy destination and the user password of a person who has copied is recorded in the electronic watermark data. Therefore, by comparing the two passwords, dishonest copying can be easily detected.

[0171] In a case where a copy is directly made between data recording media without effecting the correct user operation (S106) described in the above example, dishonest copying can be detected. That is, when the direct copying is effected, transfer information at the time of copying is subjected to the error correction process and electronic watermark data is eliminated. The "data having the electronic watermark data eliminated therefrom" is transferred to the copying destination. As a result, since data transferred to the dishonest copying destination contains no electronic watermark data, dishonest copying can be easily detected by the electronic watermark data extracting process at the data reproducing time.

[0172] FIG. 4 is a flowchart for illustrating an example of a method for reproducing data containing an electronic watermark (password) according to one embodiment of this invention.

[0173] When recorded data is reproduced from the data recording medium 201, a file data reproducing process (S127), file data storage location (directory) designating process (S128), and to-be-reproduced file data name designating process (S129) are effected in a user operation (S106).

[0174] In an operation (S122) of the disk recording/reproducing apparatus, a file data storage location (directory) accessing process (S130) and a file identifier descriptor FID searching process (S131) are effected and then a process (S132) for reading an encrypted password in the file identifier descriptor FID is effected.

[0175] In the encrypt/decrypt processing circuit 223 of FIG. 13, an encrypted password decrypting process (S133) is effected. After this, a process (S134) for accessing file entry of the designated file is effected.

[0176] In the encrypt/decrypt processing circuit 223, the decrypted password is stored in the semiconductor memory 219. Then, a process (S135) for reading out ECC block data from the data recording medium 201 is effected and the readout ECC block data is stored in the semiconductor memory 219.

[0177] The position and arrangement order of electronic watermark data inserted in the ECC block are previously known as indicated by an example of FIG. 1.

[0178] In FIG. 4, a process S136 for extracting electronic watermark data from the ECC block is effected by the address extracting section 226 for watermark data in the ECC block shown in FIG. 5. The address extracting section 226 for watermark data in the ECC block extracts only electronic watermark data from the semiconductor memory 219 and arranges the electronic watermark data in a form shown in FIG. 7B in the temporary storage section 227 for electronic watermark matrix data shown in FIG. 5.

[0179] An error correction process (S137) for electronic watermark data shown in FIG. 4 is effected by the electronic watermark data error correction section 228. The electronic watermark data error correction section 228 effects the error correcting process by use of the PI (inner parity code) 6 and PO (outer parity code) 7 and then stores the result of correction into the semiconductor memory 219.

[0180] In FIG. 4, a process (S138) for comparing the password in the file identifier descriptor FID and the password in the electronic watermark data is effected by the controller section 220 of FIG. 13. The controller section 220 reads out the user password recorded in the file identifier descriptor FID and the user password in the electronic watermark data from the semiconductor memory 219 and compares the readout passwords. If the compared passwords are different from each other, for example, an error message indicating "the data is dishonestly copied or dishonestly renewed" is issued (S139) and then the reproduction process is interrupted (S140).

[0181] If the compared passwords coincide with each other, the error correction process for the data contents of file data is effected in the ECC block error correction processing section 225 of FIG. 5 (S141) and then the resultant data is output as a reproduced signal Sc to the exterior (S142).

[0182] The error correction circuit 209 in FIG. 5 has a structure suitable for "extraction of electronic watermark data when the inserting location of the electronic watermark data in the ECC block is previously known".

[0183] As a method for extracting electronic watermark data "when the inserting location of the electronic watermark data in the ECC block is not previously known", a method for "extracting electronic watermark data by extracting an error portion in the ECC block data in the ECC block error correction processing section 225 in FIG. 5" may be used. (An electronic watermark bit inserted into the ECC block is recognized as an error at the time of reproduction of recorded data and is subjected to the error correction process. Therefore, electronic watermark data can be extracted by collecting the contents of the positions of bits which are recognized as errors in the ECC block.)

[0184] As shown in FIG. 1, if the insertion location of the electronic watermark data in the ECC block is always fixedly determined, there occurs a possibility that a third party may extract the electronic watermark data, alter the electronic watermark data and break through the copying protection. Therefore, as a modification of this invention, the insertion location of the electronic watermark data in the ECC block is periodically changed to take a measure for preventing the breakthrough of the copying protection as shown in FIG. 8 or 9.

[0185] The first embodiment of this invention has been explained in detail for the medium and recording/reproducing

apparatus with reference to the accompanying drawings.

[0186] Further, a second embodiment of this invention is explained in detail below for the medium and recording/reproducing apparatus with reference to the accompanying drawings.

[0187] The feature of the second embodiment of this invention is that the electronic watermark in the ECC block is not based on the "data contents" of the electronic watermark data, but it is based on the "inserting position" indicating the position where the electronic watermark is inserted in the ECC block and the pattern in which the electronic watermark is distributed.

[0188] That is, as shown in FIGS. 10, 11, and 12, the content (combination of "0" and "1") of the electronic watermark data has no meaning as the electronic watermark and only the "inserting position" of the electronic watermark has the meaning. In this case, the patterns of the electronic watermark inserting positions are expressed by symbols (for example, patterns A, B, C) and the symbols (A, B, C) are recorded in the file identifier descriptor FID. Then, the dishonest copying is detected by comparing the pattern detected at the ECC decoding time and the pattern recorded in the FID.

[0189] In the case of pattern A of FIG. 10, data in the extracted electronic watermark data inserting position is checked to detect electronic watermark data according to the detection rate of "1" (whether bits "1" of preset % or more are detected among the bits detected as the electronic watermark data or not).

[0190] Specifically, an address pattern corresponding to the pattern A or the like is previously stored in the semiconductor memory 219 or the like (S201). Then, when the disk recording/reproducing apparatus reads out the pattern A from the file identifier descriptor FID of the disk, an address pattern (as shown in FIG. 10) corresponding to the pattern A is read out from the semiconductor memory 219, for example. The address pattern is compared with the electronic watermark data extracted from the error correction circuit of the optical disk to detect the similarity between them (S203). If the similarity is equal to or larger than a preset value, it is determined that the electronic watermark data is detected according to the pattern A stored in the file identifier descriptor FID and the validity of the disk is determined.

[0191] In the case of pattern B of FIG. 11, it is effective to check data in the extracted electronic watermark data inserting position so as to detect electronic watermark data according to the detection rate of "0" (whether bits "0" of preset % or more are detected among the bits detected as the electronic watermark data or not).

[0192] Determination of validity of a disk is made in the same manner as in the case of FIG. 10. It is understood that the inserting positions of the electronic watermark data are set on parallel lines in the case of FIG. 10 and are set on a letter "X" in the case of FIG. 11.

[0193] In the case of pattern C of FIG. 12, data in the extracted electronic watermark data inserting position is checked and electronic watermark data can be detected according to the detection rate of a bit string of alternately and repetitively arranged "1" and "0". That is, in the pattern of FIG. 12, a bit string of alternately and repetitively arranged "1" and "0" is distributed on an oblique line. Also, in this case, when the pattern C stored in the file identifier descriptor FID is detected, an address pattern is read out from the semiconductor memory 219 according to the pattern C, for example. Then, the electronic watermark data extracted from the error correction circuit of the optical disk and the address pattern are compared to detect the similarity between them. If the similarity is equal to or larger than a preset value, it is determined that the disk is valid.

[0194] The second embodiment of this invention has been explained in detail with reference to the accompanying drawings.

[0195] Next, a UDF format used in a DVD to which the copy protecting system of this invention is applied is explained in detail below. First, the UDF format used in the DVD is explained.

〈〈〈 Schematic Explanation of UDF 〉〉〉

〈〈 What is UDF ? 〉〉

[0196] UDF is the abbreviation of a universal disk format and indicates the "rule relating to the file management method" mainly for the disk-like data recording medium. CD-ROM, CD-R, CD-RW, DVD-video, DVD-ROM, DVD-R, DVD-RAM and the like utilize the UDF format specified according to "ISO9660" which is the International Standard Specification.

[0197] As the file management method, a hierarchical file system which basically has a route directory as a parent and manages the file in a tree form is used.

[0198] In this example, the UDF format based on the DVD-RAM specification is mainly explained, but most part of the explanation can also be applied to the contents of the DVD-ROM specification.

《 Outline of UDF 》

(Recording Contents of File Data to Data Recording Medium)

[0199] When data is recorded on the data recording medium, a set of data items is called "file data" and data is recorded in the file data unit. In order to distinguish individual file data from other file data, independent file names are attached to individual file data items.
[0200] The file management and file search can be easily effected by dividing file data into groups each containing a plurality of file data items having the common data contents. The group of a plurality of file data items is called a "directory" or "folder". An independent directory name (or folder name) is attached to each directory (or folder).
[0201] Further, a plurality of directories (or folders) are collected to make an upper-level directory (or upper-level folder) as an upper-level hierarchical group. In this example, file data and directory (folder) are generally called a file.
[0202] When data is recorded, all of the data items relating to the following items (a) to (c) are recorded on a data recording medium (for example, the disk 10 shown in FIG. 1A):

(a) data contents of file data;
(b) a file name corresponding to file data; and
(c) a storage location of file data (one of the directories under which data is to be stored).
Further, all of the data items relating to the following items (d) and (e) are recorded on the data recording medium (10).
(d) the directory name (folder name) of each directory (folder); and
(e) the position to which the directory (folder) belongs (that is, the position of the upper-level directory/upper-level folder which becomes a parent thereof).

[0203] FIG. 14 is a diagram showing the basic relation between the hierarchical file system structure and data contents recorded on the data recording medium (DVD-RAM disk 10). In FIG. 14, a simple example of the hierarchical file system structure is shown on the upper side and an example of the file system recording contents according to the UDF is shown on the lower side.
[0204] In FIG. 14, the logic block (sector) size is 2048 bytes. A group of continuous logic blocks (continuous sectors) is called an "extent" (or aggregate). Access to file data recorded on the medium is made by sequentially reading data and repeatedly accessing the address indicated by the data as shown by an access route indicated by arrows.

(Simple Example of Hierarchical File System Structure)

[0205] The file management system of almost all of OS including UNIX, MacOS, MS-DOS, Windows and the like which are the general operating system (OS) of a small-size computer has a tree-form hierarchical structure as shown by an example in FIG. 14 or 20.
[0206] In FIG. 14, one route directory 401 which is a parent of the whole portion is provided for one disk drive (for example, when one hard disk drive HDD is divided into a plurality of partitions, each partition unit is considered as one disk drive) and a sub directory 402 is provided under the route directory. File data 403 is present in the sub directory 402.
[0207] In practice, the case is not limited to the above example, the file data 403 may be present directory under the route directory 401 and a complicated hierarchical structure in which a plurality of sub directories 402 are serially connected may be provided.

(File System Recording Contents on Data Recording Medium)

[0208] File system data is recorded in the logic block unit (or logic sector unit) and the following data is mainly provided as the contents recorded in each logic block.

* File ID descriptor FID (a descriptor sentence indicating file data) ... which describes the type of a file and the file name (route directory name, sub directory name, file data name, or the like). In the file ID descriptor FID, the recording positions of data relating to the contents of the directory and the data contents of file data following the FID are described.
* File entry FE (a descriptive sentence indicating the recording position of the file contents) ... which describes positions (logic block numbers) on the data recording medium in which data relating to the contents of the directory (such as the sub directory) and the contents of file data are recorded.

[0209] The central portion of FIG. 14 indicates an example of the recording contents obtained when data of the file system structure as shown in the upper side of FIG. 14 is recorded on the data recording medium 10. The contents of the above example is more specifically explained below.

* The contents of the route directory 401 are indicated in the logic block of the logic block number "1".

[0210] In the example of FIG. 14, only the sub directory 402 is present in the route directory 401. Therefore, data relating to the sub directory 402 is described in a file ID descriptor (FID) 404 as the contents of the route directory 401. Although not shown in the drawing, data of the route directory 401 itself is described in the same logic block by use of a sentence of the file ID descriptor.

[0211] In the file ID descriptor 404 of the route directory 401, the recording position of a file entry (FE) 405 indicating the position in which the contents of the sub directory 402 are recorded is described by use of the long allocation descriptor (LAD(2)).

* In the logic block of logic block number "2", the file entry 405 indicating the position in which the contents of the sub directory 402 are recorded is recorded.

[0212] In the example of FIG. 14, only the file data 403 is present in the sub directory 402. Therefore, the contents of the sub directory 402 substantially indicate the recording position of a file ID descriptor 406 in which data relating to the file data 403 is described.

[0213] In the file entry 405, the short allocation descriptor therein describes (AD(3)) that the contents of the sub directory 402 are recorded in the third logic block.

* The contents of the sub directory 402 are recorded in the logic block of logic block number "3".

[0214] In the example of FIG. 14, since only the file data 403 is present in the sub directory 402, data relating to the file data 403 is described by the file ID descriptor 406 as the contents of the sub directory 402. Although not shown in the drawing, data of the sub directory 402 itself is described in the same logic block by a sentence of the file ID descriptor.

[0215] In the file ID descriptor 406 relating to the file data 403, the recording position of a file entry 407 indicating the position in which the contents of the file data 403 are recorded is described by use of the long allocation descriptor (LAD(4)).

* In the logic block of logic block number "4", the file entry 407 indicating the position in which the contents (408, 409) of the file data 403 are recorded is recorded.

[0216] It is described (AD(5), AD(6)) that the contents (408, 409) of the file data 403 are recorded in the fifth and sixth logic blocks by the short allocation descriptor in the file entry 407.

* In the logic block of logic block number "5", the contents 408 of the file data 403 are recorded.
* In the logic block of logic block number "6", the contents 409 of the file data 403 are recorded.

(Method for Accessing File Data along Data of FIG. 14)

[0217] As described above, in the file ID descriptor FID and file entry FE, logic block numbers describing data items succeeding thereto are described.

[0218] In the same manner as a method for reaching file data via the sub directory while descending the hierarchy from the route directory, the contents of the target file data are accessed while data in the logic block on the data recording medium 10 is sequentially reproduced according to the logic block numbers described in the file ID descriptor FID and file entry.

[0219] That is, in order to access the file data 403 shown in FIG. 14, first, the first logic block data is read out and then the second logic block data is read out according to LAD(2) contained therein. Since the file data 403 is present in the sub directory 402, the file ID descriptor FID of the sub directory 402 is searched for to read AD(3). Then, the third logic block data is read out according to the readout AD(3). Since LAD(4) is described in the readout data, the fourth logic block data is read out, and the file ID descriptor FID relating to the file data 403 is searched for, the fifth logic block data is read out according to AD(5) described therein, and then the sixth logic block is reached according to AD(6).

[0220] The contents of the description of AD (logic block number) and LAD (logic block number) are described later.

⟨⟨⟨ Specific Explanation of Contents of Each Descriptive Sentence (Descriptor) of UDF⟩⟩⟩

⟨⟨ Descriptive Sentence of Logic Block Number⟩⟩

⟨Allocation Descriptor⟩

[0221] As described in the item ⟨File System Data Recording Contents on Data Recording Medium⟩ a descriptive sentence indicating the position (logic block number) in which data contained in part of the file ID descriptor FID and file entry and succeeding thereto is recorded is called an allocation descriptor.
[0222] The allocation descriptor includes a long allocation descriptor and short allocation descriptor.

⟨Long Allocation Descriptor⟩

[0223] FIG. 15 is a diagram for illustrating the descriptive contents of the long allocation descriptor indicating the recording position of a continuous sector aggregate (extent) on the data recording medium.
[0224] The long allocation descriptor LAD (logic block number) is defined by the length 410 of the extent, position 411 of the extent, and implementation use 412.
[0225] The length 410 of the extent expresses the logic block number by use of 4 bytes, the position 411 of the extent expresses the corresponding logic block number by use of 4 bytes, and the implementation use 412 expresses data used for the calculation process by use of 8 bytes.
[0226] In this example, in order to simplify the description, an abbreviated symbol of "LAD (logic block number)" is used for describing the long allocation descriptor.

⟨Short Allocation Descriptor⟩

[0227] FIG. 16 is a diagram for illustrating the descriptive contents of the short allocation descriptor indicating the recording position of a continuous sector aggregate (extent) on the data recording medium 10.
[0228] The short allocation descriptor AD (logic block number) is defined by the length 410 of the extent and position 411 of the extent.
[0229] The length 410 of the extent expresses the logic block number by use of 4 bytes, and the position 411 of the extent expresses the corresponding logic block number by use of 4 bytes.
[0230] In this example, in order to simplify the description, an abbreviated symbol of "AD (logic block number)" is used for describing the short allocation descriptor.

⟨Unallocated Space Entry⟩

[0231] FIG. 17 is a diagram for illustrating the contents of a descriptive sentence used as an unallocated space entry (USE) for searching for a non-recorded continuous sector aggregate (non-recorded extent) on the data recording medium.
[0232] In FIG. 17, the file type = 1 in an ICB tag indicates an unallocated space entry, the file type = 4 in the ICB tag indicates a directory and the file type = 5 in the ICB tag indicates file data.
[0233] The unallocated space entry is a descriptive sentence used in the space table (refer to FIGS. 21 to 23) indicating the "recorded logic block" or "non-recorded logic block" in the recording area of the data recording medium 10.
[0234] The unallocated space entry USE includes a descriptive tag 413, ICB tag 414, total length of allocation descriptive string 415, and allocation descriptor 416.

* The descriptive tag 413 indicates an identifier of the description contents and it is set to "263" in this example.
* The ICB tag 414 indicates a file type.

[0235] The file type = 1 in the ICB tag indicates an unallocated space entry USE, the file type = 4 indicates a directory and the file type = 5 indicates file data.

* The total length of allocation descriptive string 415 expresses the total byte number of the allocation descriptive string by use of four bytes.
* The allocation descriptor 416 is a list of recording positions (logic block numbers) on the medium 10 of each extent (sector aggregate). For example, they are listed as (AD(*), AD(*), ......, AD(*)).

⟨File Entry⟩

[0236] FIG. 18 is a diagram for illustrating an extracted part of the description contents of file entry which indicates the recording position of a file specified in the file structure having the hierarchical structure as shown in FIG. 14.
[0237] In FIG. 18, the file type = 1 in the ICB tag indicates an unallocated space entry, the file type = 4 in the ICB tag indicates a directory and the file type = 5 in the ICB tag indicates file data.
[0238] The file entry includes a descriptive tag 417, ICB tag 418, permission data 419 and allocation descriptor 420.

* The descriptive tag 417 indicates an identifier of the description contents and it is set to "261" in this example.
* The ICB tag 418 indicates a file type and the contents thereof are the same as the contents of the ICB tag 414 of the unallocated space entry of FIG. 17.
* The permission data 419 indicates permission data for the record/reproduce/delete process for each user. It is mainly used for attaining the security of the file.
* The allocation descriptor 420 describes the position in which the contents of the file are recorded by arranging the short allocation descriptors for each extent. For example, they are arranged as FE(AD(*), AD(*), ......, AD(*)).

⟨File ID Descriptor FID⟩

[0239] FIG. 19 is a diagram for illustrating an extracted part of the file ID descriptor which describes data of the file (route directory, sub directory, file data and the like) in the file structure having the hierarchical structure as shown in FIG. 14.
[0240] In FIG. 19, the file characteristic (for each file type) indicates one of the parent directory, directory, file data and file elimination flag. As the setting example of the AV file identifier (424), 1) an independent extension (.VOB, for example) is attached as the file identifier, and 2) an independent flag is inserted into the padding (437).
[0241] The file ID descriptor FID includes a descriptive tag 421, file character 422, data control block ICB 423, file identifier 424 and padding 437.

* The descriptive tag 421 indicates an identifier of the description contents and it is set to "257" in this example.
* The file character 422 indicates a file type and indicates one of the parent directory, directory, file data and file elimination flag.
* The data control block ICB 423 describes the FE position (file entry position) corresponding to the file by use of the long allocation descriptor.
* The file identifier 424 describes the directory name or file name.
* The padding 437 is a dummy field added for adjusting the total length of the file identifier 424 and "0" (or "000h") is generally recorded in all positions.

[0242] In this invention, computer data (DA1, DA3) and AV data (DA2) can be present at the same time in one volume space. In this case, two types of files, that is, computer file and AV file can mixedly be present as the file.
[0243] As the setting method for setting the AV file identifier for distinguishing the AV file from the computer file, the following two methods are considered.

1) A preset extension (.VOB, for example) is attached to the end of the file name of the AV file;
2) An independent flag (not shown) is inserted in the padding 437 of the AV file (the flag of "1" indicates an AV file and the flag of "0" indicates a computer file, for example).

[0244] Further, an encrypted user password can be recorded in the field of the padding 437.
[0245] FIG. 20 is a diagram showing a file system structure obtained by more generalizing the file structure as indicated by the example in FIG. 14. In FIG. 20, numerals in parentheses indicate data relating to the contents of the directory or logic block numbers on the data recording medium 10 in which the data contents of file data are stored, for example.

⟨⟨⟨ Example of File Structure Description Recorded according to UDF⟩⟩⟩

[0246] The content (the structure of the file system) described in the item ⟨⟨Outline of UDF ⟩⟩is explained below.
[0247] As the management method of non-recorded position on the data recording medium (such as a DVD-RAM disk) 10, the following methods are provided.

[Space Bit Map Method]

[0248] This method is a method using a space bit map descriptor for setting a flag of "recorded" or "non-recorded" in the bit map manner in all of the logic blocks of the recording area of the data recording medium.

[Space Table Method]

[0249] This method is a method for describing the recorded logic block number by listing the short allocation descriptors by use of the descriptive system of FIG. 17.

[0250] In this case, in order to simultaneously explain both of the methods, both methods (space bit map method and space table method) are shown in FIGS. 21 to 23, but in practice, it is rare to simultaneously use the two methods (record data on the data recording medium) and only one of the two methods is used.

[0251] Further, the description content (the arrangement and description of the short allocation descriptor) in the space table is set according to the file system structure of FIG. 20, but this is not limitative and the short allocation descriptor can be freely described.

[0252] FIGS. 21 to 23 show an example in which data of the file system structure of FIG. 20 is recorded on the data recording medium 10 according to the UDF format. FIG. 21 shows the front portion thereof, FIG. 22 shows the middle portion thereof and FIG. 23 shows the latter portion thereof.

[0253] In FIG. 23, LSN = logic sector number 491, LSN = logic block number 492 and LLSN = final logic sector number 493, and it is rare to simultaneously record the space bit map and space table and, generally, only one of the space bit map and the space table is recorded.

[0254] As shown in FIGS. 21 to 23, a logic sector in which data relating to the file structure 486 and file data 487 is recorded is particularly called a "logic block", and a logic block number (LBN) is set in connection with the logic sector number (LSN) (the length of the logic block is 2048 bytes like the logic sector).

[0255] The contents of the main descriptors described in FIGS. 21 to 23 are as follows.

* Extent area descriptive start 445 indicates the start position of a volume recognition sequence (VRS).
* A volume structure descriptor 446 describes the explanation for the contents of a disk (the contents of the volume).
* A boot descriptor 447 is a portion which describes the process contents at the boot time, for example, the boot start position of the computer system.
* Extent area descriptive end 448 indicates the end position of the volume recognition sequence (VRS).
* A partition descriptor 450 describes partition data such as the size of the partition.

[0256] In the DVD-RAM, one partition is assigned for each volume as a general rule.

* A logic volume descriptor 454 describes the contents of the logic volume.
* An anchor volume descriptive pointer 458 indicates the record end position of recorded data in the recording area of the data recording medium 10.
* Reserve data items 459 to 465 are adjusting areas for acquiring logic sector numbers for recording specified descriptors and "00h" is written therein at first.
* A reserve volume descriptive sequence 467 is a backup area of data recorded in the main volume descriptive sequence 449.

⟨⟨⟨ Access Method to File Data at Reproducing Time ⟩⟩⟩

[0257] A method for accessing file data on the data recording medium 10 is explained by considering a case wherein, for example, the data content of file data H432 of FIG. 2 is reproduced by use of file system data shown in FIGS. 21 to 23.

(1) Data of the boot descriptor 447 in the area of the volume recognition sequence 444 as the boot area at the time of start of the disk recording/reproducing apparatus or at the time of loading of the data recording medium is reproduced. The process at the boot time is started according to the description contents of the boot descriptor 447.

At this time, if there is no specified process at the boot time, the following operation is effected.

(2) First, data of the logic volume descriptor 454 in the area of the main volume descriptive sequence 449 is reproduced.

(3) Logic volume contents usage 455 is described in the logic volume descriptor 454. In this portion, a logic block number indicating the position in which the file set descriptor 472 is recorded is described in the form of long allocation descriptor (FIG. 15) (in the example of FIGS. 21 to 23, LAD(100) is set, and therefore, it is recorded in the

100th logic block).

(4) The 100th logic block (400th in the logic sector number) is accessed to reproduce the file set descriptor 472. In the route directory ICB473 of the file set descriptor, a position (logic block number) in which the file entry relating to the route directory A425 is recorded is described in the form of long allocation descriptor (FIG. 15) (in the example of FIGS. 21 to 23, LAD(102) is set, and therefore, it is recorded in the 102nd logic block).

In this case, according to LAD(102) of the route directory ICB 473, the following operation is effected.

(5) The 102nd logic block is accessed to reproduce the file entry 475 relating to the route directory A425 and read out the position (logic block number) in which data relating to the contents of the route directory A425 is recorded (AD(103) : recorded in the 103rd logic block).

(6) The 103rd logic block is accessed to reproduce data relating to the contents of the route directory A425.

Since the file data H432 lies under the directory D428 series, a file ID descriptor FID relating to the directory D428 is searched for and a logic block number (LAD(110) : recorded in the 110th logic block, although not shown in FIGS. 21 to 23) in which the file entry relating to the directory D428 is recorded is read out.

(7) The 110th logic block is accessed to reproduce the file entry 480 relating to the directory D428 and read out the position (logic block number) in which data relating to the contents of the directory D428 is recorded (AD(111) : recorded in the 111th logic block).

(8) The 111th logic block is accessed to reproduce data relating to the contents of the directory D428.

Since the file data H432 lies directly under the sub directory F430, a file ID descriptor FID relating to the sub directory F430 is searched for and a logic block number (LAD(112) : recorded in the 112th logic block) in which the file entry relating to the sub directory F430 is recorded is read out.

(9) The 112th logic block is accessed to reproduce the file entry 482 relating to the sub directory F430 and read out the position (logic block number) in which data relating to the contents of the sub directory F430 is recorded (AD(113) : recorded in the 113th logic block).

(10) The 113th logic block is accessed to reproduce data relating to the contents of the sub directory F430 and a file ID descriptor FID relating to the file data H432 is searched for. Then, a logic block number in which the file entry relating to the file data H432 is recorded is read out (LAD(114) : recorded in the 114th logic block).

(11) The 114th logic block is accessed to reproduce the file entry 484 relating to the file data H432 and read out the position in which the data content 489 of the file data H432 is recorded.

(12) Data is reproduced from the data recording medium in an order of the logic block number described in the file entry 484 relating to the file data H432 and the data content 489 of the file data H432 is read out.

⟨⟨⟨Specified File Data Contents Changing Method⟩⟩⟩

[0258] Next, the processing method including the access method is explained in a case wherein, for example, the data content of the file data H432 is changed by use of the file system data shown in FIGS. 21 to 23.

(1) A difference between the amounts of data contents before and after the change of the file data H432 is derived, the difference is divided by 2048 bytes, and the number of logic blocks which becomes necessary or unnecessary for recording data obtained after the change is previously calculated.

(2) Data of the boot descriptor 447 in the area of the volume recognition sequence 444 as the boot area at the time of start of the disk recording/reproducing apparatus or at the time of loading of the data recording medium is reproduced. The process at the boot time is started according to the description contents of the boot descriptor 447.

At this time, if there is no specified process at the boot time, the following operation is effected.

(3) First, the partition descriptor 450 in the area of the main volume descriptor sequence 449 is reproduced and data of the partition contents usage 451 described therein is read out. The recording position of the space table or space bit map is indicated in the partition contents usage 451 (which is also called a partition header descriptor).

- The space table position is described in the form of short allocation descriptor in the column of the unallocated space table 452 (AD(80) in the example of FIGS. 21 to 23).
- The space bit map position is described in the form of short allocation descriptor in the column of the unallocated space bit map 453 (AD(0) in the example of FIGS. 21 to 23).

(4) Access is made to the logic block number (0) in which the space bit map read out in the item (3) is described. Space bit map data is extracted from the space bit map descriptor, a non-recorded logic block is searched for, and use of logic blocks of a number obtained as the calculation result of the item (1) is registered (space bit map descriptive data rewriting process).

(4*) Access is made to the logic block number (80) in which the space table read out in the item (3) is described. Data from the unallocated space entry USE (AD(*)) of the space table to USE (AD(*), AD(*)) of the file data I is read

out, a non-recorded logic block is searched for, and use of logic blocks of a number obtained as the result of calculation in the item (1) is registered (space table data rewriting process).

In the actual process, one of the processes (4) and (4*) is effected.

(5) Next, data of the logic volume descriptor 454 in the area of the main volume descriptive sequence 449 is reproduced.

(6) Logic volume contents usage 455 is described in the logic volume descriptor 454. In this portion, a logic block number indicating the position in which the file set descriptor 472 is recorded is described in the form of long allocation descriptor (FIG. 15) (it is recorded in the 100th logic block based on LAD(100) in the example of FIGS. 21 to 23).

(7) The 100th logic block (400th in the logic sector number) is accessed to reproduce the file set descriptor 472. The position (logic block number) in which the file entry relating to the route directory A425 is recorded is described in the form of long allocation descriptor (FIG. 15) in the route directory ICB 473 of the file set descriptor (it is recorded in the 102nd logic block based on LAD(102) in the example of FIGS. 21 to 23).

The following operation is effected according to LAD(102) in the route directory ICB 473.

(8) The 102nd logic block is accessed to reproduce the file entry 475 relating to the route directory A425 and read out the position (logic block number) in which data relating to the contents of the route directory A425 is recorded (AD(103)).

(9) The 103rd logic block is accessed to reproduce data relating to the contents of the route directory A425.

Since the file data H432 lies under the directory D428 series, a file ID descriptor FID relating to the directory D428 is searched for and a logic block number (LAD(110)) in which the file entry relating to the directory D428 is recorded is read out.

(10) The 110th logic block is accessed to reproduce the file entry 480 relating to the directory D428 and read out the position (logic block number) in which data relating to the contents of the directory D428 is recorded (AD(111)).

(11) The 111th logic block is accessed to reproduce data relating to the contents of the directory D428.

Since the file data H432 lies directly under the sub directory F430, a file ID descriptor FID relating to the sub directory F430 is searched for and a logic block number (LAD(112)) in which the file entry relating to the sub directory F430 is recorded is read out.

(12) The 112th logic block is accessed to reproduce the file entry 482 relating to the sub directory F430 and read out the position (logic block number) in which data relating to the contents of the sub directory F430 is recorded (AD(113)).

(13) The 113th logic block is accessed to reproduce data relating to the contents of the sub directory F430 and a file ID descriptor FID relating to the file data H432 is searched for. Then, a logic block number (LAD(114)) in which the file entry relating to the file data H432 is recorded is read out.

(14) The 114th logic block is accessed to reproduce the file entry 484 relating to the file data H432 and read out the position in which the data content 489 of the file data H432 is recorded.

(15) The data contents 489 of the file data H432 obtained after the change are recorded by taking the logic block number additionally registered in the process (4) or (4*) into consideration.

《《 Specified File Data/Directory Delete Processing Method 》》

[0259] As one example, a method for deleting the file data H432 or sub directory F430 is explained.

(1) Data of the boot descriptor 447 in the area of the volume recognition sequence 444 as the boot area at the time of start of the disk recording/reproducing apparatus or at the time of loading of the data recording medium is reproduced. The process at the boot time is started according to the description contents of the boot descriptor 447.

At this time, if there is no specified process at the boot time, the following operation is effected.

(2) First, data of the logic volume descriptor 454 in the area of the main volume descriptor sequence 449 is reproduced.

(3) Logic volume contents usage 455 is described in the logic volume descriptor 454, and in this portion, a logic block number indicating the position in which the file set descriptor 472 is recorded is described in the form of long allocation descriptor (FIG. 15) (in the example of FIGS. 21 to 23, it is recorded in the 100th logic block based on LAD(100)).

(4) The 100th logic block (400th in the logic sector number) is accessed to reproduce the file set descriptor 472. In the route directory ICB473 of the file set descriptor, a position (logic block number) in which the file entry relating to the route directory A425 is recorded is described in the form of long allocation descriptor (FIG. 15) (in the example of FIGS. 21 to 23, it is recorded in the 102nd logic block based on LAD(102)).

In this case, according to LAD(102) of the route directory ICB 473, the following operation is effected.

(5) The 102nd logic block is accessed to reproduce the file entry 475 relating to the route directory A425 and read

out the position (logic block number) in which data relating to the contents of the route directory A425 is recorded (AD(103)).

(6) The 103rd logic block is accessed to reproduce data relating to the contents of the route directory A425.

Since the file data H432 lies under the directory D428 series, a file ID descriptor FID relating to the directory D428 is searched for and a logic block number (LAD(110)) in which the file entry relating to the directory D428 is recorded is read out.

(7) The 110th logic block is accessed to reproduce the file entry 480 relating to the directory D428 and read out the position (logic block number) in which data relating to the contents of the directory D428 is recorded (AD(111)).

(8) The 111th logic block is accessed to reproduce data relating to the contents of the directory D428.

Since the file data H432 lies directly under the sub directory F430, a file ID descriptor FID relating to the sub directory F430 is searched for.

Assume now that the sub directory F430 is deleted. In this case, a "file delete flag" is set in the file characteristic 422 (FIG. 19) in the file ID descriptor FID relating to the sub directory F430.

Then, a logic block number (LAD(112)) in which the file entry relating to the sub directory F430 is recorded is read out.

(9) The 112th logic block is accessed to reproduce the file entry 482 relating to the sub directory F430 and read out the position (logic block number) in which data relating to the contents of the sub directory F430 is recorded (AD(113)).

(10) The 113th logic block is accessed to reproduce data relating to the contents of the sub directory F430 and a file ID descriptor FID relating to the file data H432 is searched for.

Next, assume that the file data H432 is deleted. In this case, a "file delete flag" is set in the file characteristic 422 (FIG. 19) in the file ID descriptor FID relating to the sub directory H432.

Then, a logic block number (LAD(114)) in which the file entry relating to the file data H432 is recorded is read out.

(11) The 114th logic block is accessed to reproduce the file entry 484 relating to the file data H432 and read out the position in which the data content 489 of the file data H432 is recorded.

In a case wherein the file data H432 is deleted, a logic block in which the data content 489 of the file data H432 is recorded is released by the following method (the logic block is registered as the non-record state).

(12) Next, the partition descriptor 450 in the area of the main volume descriptive sequence 449 is reproduced to read out data of the partition contents usage 451 described therein. The recording position of the space table or space bit map is indicated in the partition contents usage (partition header descriptor) 451.

- The space table position is described in the form of short allocation descriptor in the column of the unallocated space table 452 (AD(80) in the example of FIGS. 21 to 23).
- The space bit map position is described in the form of short allocation descriptor in the column of the unallocated space bit map 453 (AD(0) in the example of FIGS. 21 to 23).

(13) The logic block number (0) in which the space bit map read out in the process (12) is described is accessed and the "to-be-released logic block number" obtained as the result of the process (11) is rewritten to the space bit map descriptor.

(13*) The logic block number (80) in which the space table read out in the process (12) is described is accessed and the "to-be-released logic block number" obtained as the result of the process (11) is rewritten to the space table.

In the actual process, one of the processes (13) and (13*) is effected.

In a case where the file data H432 is deleted, the following processes are effected.

(12) The same processes as the above processes (10) and (11) are effected to read out the position in which the data content 490 of file data I 433 is recorded.

(13) Next, the partition descriptor 450 in the area of the main volume descriptive sequence 449 is reproduced to read out data of the partition contents usage 451 described therein. The recording position of the space table or space bit map is indicated in the partition contents usage (partition header descriptor) 451.

- The space table position is described in the form of short allocation descriptor in the column of the unallocated space table 452 (AD(80) in the example of FIGS. 21 to 23).
- The space bit map position is described in the form of short allocation descriptor in the column of the unallocated space bit map 453 (AD(0) in the example of FIGS. 21 to 23).

(14) The logic block number (0) in which the space bit map read out in the process (13) is described is accessed and the "to-be-released logic block number" obtained as the result of the processes (11) and (12) is rewritten to the

space bit map descriptor.

(14*) The logic block number (80) in which the space table read out in the process (13) is described is accessed and the "to-be-released logic block number" obtained as the result of the processes (11) and (12) is rewritten to the space table.

[0260] In the actual process, one of the processes (14) and (14*) is effected.

⟨⟨⟨ File Data/Directory Adding Process ⟩⟩⟩

[0261] As one example, an accessing/adding processing method for newly adding file data or directory under the sub directory F430 is explained.

(1) In the case of adding file data, the capacity of the file data contents to be added is checked, the value is divided by 2048 bytes, and the number of logic blocks necessary for adding the file data is previously calculated.

(2) Data of the boot descriptor 447 in the area of the volume recognition sequence 444 as the boot area at the time of start of the disk recording/reproducing apparatus or at the time of loading of the data recording medium is reproduced. The process at the boot time is started according to the description contents of the boot descriptor 447.

At this time, if there is no specified process at the boot time, the following operation is effected.

(3) First, the partition descriptor 450 in the area of the main volume descriptive sequence 449 is reproduced to read out data of the partition contents usage 451 described therein. The recording position of the space table or space bit map is indicated in the partition contents usage (partition header descriptor) 451.

* The space table position is described in the form of short allocation descriptor in the column of the unallocated space table 452 (AD(80) in the example of FIGS. 21 to 23).
* The space bit map position is described in the form of short allocation descriptor in the column of the unallocated space bit map 453 (AD(0) in the example of FIGS. 21 to 23).

(4) The logic block number (0) in which the space bit map read out in the process (3) is described is accessed. Space bit map data is extracted from the space bit map descriptor, a non-recorded logic block is searched for, and use of logic blocks of a number obtained as the result of calculation in the process (1) is registered (space bit map descriptive data rewriting process).

(4*) The logic block number (80) in which the space table read out in the process (3) is described is accessed. Data from USE (AD(*)) 461 of the space table to USE (AD(*), AD(*)) 470 of the file data I is read out, a non-recorded logic block is searched for, and use of logic blocks of a number obtained as the result of calculation in the process (1) is registered (space table data rewriting process).

In the actual process, one of the processes (4) and (4*) is effected.

(5) Next, data of the logic volume descriptor 454 in the area of the main volume descriptive sequence 449 is reproduced.

(6) Logic volume contents usage 455 is described in the logic volume descriptor 454, and in this portion, a logic block number indicating the position in which the file set descriptor 472 is recorded is described in the form of long allocation descriptor (FIG. 15) (it is recorded in the 100th logic block based on LAD(100) in the example of FIGS. 21 to 23).

(7) The 100th logic block (400th in the logic sector number) is accessed to reproduce the file set descriptor 472. The position (logic block number) in which the file entry relating to the route directory A425 is recorded is described in the form of long allocation descriptor (FIG. 15) in the route directory ICB 473 of the file set descriptor (the file entry relating to the route directory A425 is recorded in the 102nd logic block based on LAD(102) in the example of FIGS. 21 to 23).

The following processes are effected according to LAD(102) of the route directory ICB 473.

(8) The 102nd logic block is accessed to reproduce the file entry 475 relating to the route directory A425 and read out the position (logic block number) in which data relating to the contents of the route directory A425 is recorded (AD(103)).

(9) The 103rd logic block is accessed to reproduce data relating to the contents of the route directory A425.

A file ID descriptor FID relating to the directory D428 is searched for and a logic block number (LAD(110)) in which the file entry relating to the directory D428 is recorded is read out.

(10) The 110th logic block is accessed to reproduce the file entry 480 relating to the directory D428 and read out the position (logic block number) in which data relating to the contents of the directory D428 is recorded (AD(111)).

(11) The 111th logic block is accessed to reproduce data relating to the contents of the directory D428.

A file ID descriptor FID relating to the sub directory F430 is searched for and a logic block number (LAD(112))

in which the file entry relating to the sub directory F430 is recorded is read out.

(12) The 112th logic block is accessed to reproduce the file entry 482 relating to the sub directory F430 and read out the position (logic block number) in which data relating to the contents of the sub directory F430 is recorded (AD(113)).

(13) The 113th logic block is accessed to register the file ID descriptor FID of the directory or file data to be newly added to data relating to the contents of the sub directory F430.

(14) The logic block number position registered in the process (4) or (4*) is accessed to describe the file entry relating to the directory or file data to be newly added.

(15) The logic block number position described in the short allocation descriptor in the file entry in the process (14) is accessed to record data contents of file data to be added or the file ID descriptor FID of a parent directory relating to the directory to be added.

[0262] In FIGS. 21 to 23, LSN is an abbreviated symbol indicating the logic sector number (LSN) 491, LBN is an abbreviated symbol indicating the logic block number (LBN) 492, and LLSN is an abbreviated symbol indicating the last logic sector number (last LSN) 493.

⟨⟨ Feature of UDF ⟩⟩

⟨Explanation for Feature of UDF⟩

[0263] The feature of the universal data format UDF is explained below in comparison with the file allocation table FAT used in a hard disk HDD, floppy disk FDD, optical-magnetic disk MO or the like.

(1) In the FAT, the management table (file allocation table) of allocation of a file to the data recording medium is locally and collectively recorded on the data recording medium, but in the UDF, file management data can be distributed and recorded in desired positions on the disk.

Since management data is collectively controlled in the file management area in the FAT, it is suitable for application which requires the file structure to be frequently altered (particularly, for frequently rewriting application) (this is because management data is recorded in a concentrated position and can be easily rewritten). In the FAT, since the recording position of file management data is previously determined, it is necessary to use a recording medium of high reliability (having a less defective area).

In the UDF, since file management data is arranged in a distributed manner, and it is suitable for application (mainly, additionally describing application) in which the file structure is not so often greatly changed and a new file structure is added later to a portion under the hierarchy (mainly, a portion under the route directory) (this is because an altering portion of the former file management data is less at the time of additional description).

Further, since recording position of the distributed file management data can be freely specified, it is possible to record data in a position other than the inherent defective portion.

Further, since file management data can be recorded in a desired position, the advantage of the FAT can be attained by collectively recording all of the file management data items in one portion and it can be considered as a file system having a great deal of flexibility.

(2) In the UDF, the minimum unit (such as the minimum logic block size or minimum logic sector size) is large and it is suitable for recording of video data or music data having a large amount of recording data.

[0264] That is, the logic sector size of FAT is 512 bytes, but the logic sector (block) size of UDF is 2048 bytes and is thus larger.

[0265] In the UDF, the recording position on the disk for file data and file management data is described in the allocation descriptor as a logic sector (block) number.

[0266] A medium on which digital data having an error correction code attached thereto can be recorded is used as a data recording medium used in the copy protect system using the electronic watermark according to this invention. Data obtained by adding electronic watermark data whose capacity does not exceed the error correction ability of the reproducing side to the digital data is recorded on the data recording medium.

[0267] When data is reproduced from the data recording medium, the position in which the electronic watermark data is recorded on the data recording medium or the contents of the electronic watermark data are extracted and read out in a reproducing apparatus (or reproducing method) of this invention. Whether data recorded on the data recording medium is original data or dishonestly copied data is determined based on the thus extracted and readout data contents.

[0268] The following effects can be attained by using the copy protect system using the electronic watermark according to this invention.

(1) Dishonest copying on a recordable digital data recording medium such as a DVD-RAM disk can be stably and strongly prevented by a relatively simple method.

(2) This invention can be applied to any type of data recording medium, for example, a recordable/deletable data recording medium such as a DVD-RAM disk, a data recording medium such as a DVD-R in which data can be only additionally recorded or a reproducing-only data recording medium such as a DVD-ROM, DVD video.

Further, the following effects can be attained by applying a copy protect system using the electronic watermark according to this invention to an actual product.

(3) The structure of a disk reproducing apparatus or disk recording/reproducing apparatus can be simplified or the parts thereof can be commonly used by providing the same copy protect function for various types of disk reproducing apparatuses and disk recording/reproducing apparatuses such as rewritable disk recording/reproducing apparatuses and reproducing-only disk reproducing apparatuses.

(4) Since the safe and strong copy protect function can be attained by adding a simple circuit to the conventional disk reproducing apparatus or disk recording/reproducing apparatus, the cost of the apparatus can be easily lowered.

(5) A person who has formed file data inputs a password when the formed file data is recorded on a data recording medium. The same data of the "password" is encrypted and recorded in the file management area (in the FID) and it is recorded as electronic watermark data having a recording form different from that of the former data in a position (which is different from the file management area) in which the data contents of the file data are recorded. Thus, dishonest copying can be positively detected by recording the same data of the "password" in different recording forms in different positions on the data recording medium and comparing the recorded data items.

(6) An error correction code is attached to the electronic watermark data itself, and therefore, even if an error is introduced into the electronic watermark data because of the defect on the data recording medium on which it is recorded, the error can be corrected and correct data can be reproduced.

## Claims

1. A copy protecting method for an optical medium characterized by comprising:

   a writing step (FIG. 2, S113, FIG. 3, S127) of writing watermark data (FIG. 1B, a to p) as ECC data in a data storage area (25, 11, 12, 13) of a disk (10) having a certain data stored therein.

2. A copy protecting method according to claim 1, characterized by further comprising:

   an extraction step (FIG. 4, S136) of extracting the watermark data from the ECC data of the disk; and
   a determining step (S138) of comparing the extracted watermark data with collation data (PW) and determining a validity of the disk based on the result of comparison.

3. A copy protecting method according to claim 2, characterized by further comprising an outputting step (S141, S142) of deleting the watermark data from the certain data stored in the disk after said determining step and reading out and outputting only the certain data.

4. A copy protecting method according to claim 1, characterized by further comprising:

   a second writing step (S111) of writing the collation data in a preset position of the data storage area (25, 11, 12, 13) of the disk;
   an extraction step (FIG. 4, S136) of extracting the watermark data from the ECC data of the disk; and
   a determining step (S138) of reading out the collation data written in said second writing step from the preset position, comparing the extracted watermark data with the readout collation data and determining the validity of the disk based on the result of comparison.

5. A copy protecting method according to claim 1, characterized by further comprising:

   an encrypting step (S107) of encrypting the collation data;
   a writing step (S111) of writing the encrypted collation data into the preset position of the data storage area (25, 11, 12, 13) of the disk;
   a decrypting step (S133) of reading out and decrypting the encrypted collation data written in the preset position; and
   a determining step (S138) of comparing the decrypted collation data decrypted in said decrypting step and the

extracted watermark data and determining a validity of the disk based on the result of comparison.

6. A copy protecting method according to claim 2, characterized by further comprising:

a storing step (S201) of storing the collation data relating to the inserting position of the watermark data into a storage area (219) of a reproducing apparatus for the disk which effects said determining step; and
a determining step (S203) of comparing the inserting position of the extracted watermark data and the collation data relating to the inserting position of the watermark data stored in said storing step and determining a validity of the disk based on the result of comparison.

7. An optical medium characterized by comprising:

a data storage area (28) formed on a disk (10), for storing data; and
a plurality of ECC blocks (25, 11, 12, 13) provided in said data storage area, for storing watermark data (FIG. 1B, a to p) as ECC data together with a certain data.

8. An optical medium according to claim 7, characterized in that the electronic watermark data is deleted by an error correction function in a reproducing apparatus for reading the optical medium.

9. An optical medium according to claim 7, characterized in that said data storage area includes a data storage area (28) for storing collation data (PW) which is compared with the electronic watermark data, for determining a validity of the optical medium in a reproducing apparatus for reading the optical medium.

10. An optical medium according to claim 7, characterized in that said data storage area includes a data storage area (28) for storing collation data (PW) in an encrypted form which is compared with the electronic watermark data, for determining a validity of the optical medium in a reproducing apparatus for reading the optical medium.

11. An optical medium according to claim 7, characterized in that the watermark data consists of bits "1" or "0" and is regularly arranged in said plurality of ECC blocks.

12. An optical disk reproducing apparatus characterized by comprising:

extraction means (FIG. 4, S136, 229) for extracting watermark data from ECC data of a disk in which the watermark data (FIG. 1B, a to p) is written as the ECC data in a data storage area (25, 11, 12, 13) of the disk having a certain data stored therein; and
reproduction means (222) for reproducing the certain data stored in the data storage area of disk.

13. An optical disk reproducing apparatus according to claim 12, characterized by further comprising:

determining means (219, 220, S138) for comparing the extracted watermark data with collation data (PW) and determining a validity of the disk based on the result of comparison; and
outputting means (222, 224) for deleting the watermark data and error data from the certain data based on the ECC data and outputting the certain data subjected to the deletion process.

14. An optical disk reproducing apparatus according to claim 13, characterized in that said determining means includes determining means (219, 220, S138) for reading out the collation data (PW) from the disk, comparing the extracted watermark data with the collation data (PW) and determining the validity of the disk based on the result of comparison.

15. An optical disk reproducing apparatus according to claim 13, characterized in that said determining means includes determining means (219, 220, S133, S138) for reading out the collation data (PW) from the disk and encrypting the same, comparing the extracted watermark data with the encrypted collation data and determining the validity of the disk based on the result of comparison.

16. An optical disk reproducing apparatus according to claim 13, characterized in that said determining means includes determining means (219, 220, S138) for comparing the inserting position of the watermark data in the ECC block of the extracted watermark data with the collation data having inserting position data and determining the validity of the disk based on the result of comparison.

17. An optical disk reproducing apparatus according to claim 13, characterized in that said determining means includes determining means (219, 220, S138) for reading out the collation data having inserting position data stored in the storage area (219) of the optical disk reproducing apparatus, comparing the inserting position of the watermark data in the ECC block of the extracted watermark data with the readout collation data and determining the validity of the disk based on the result of comparison.

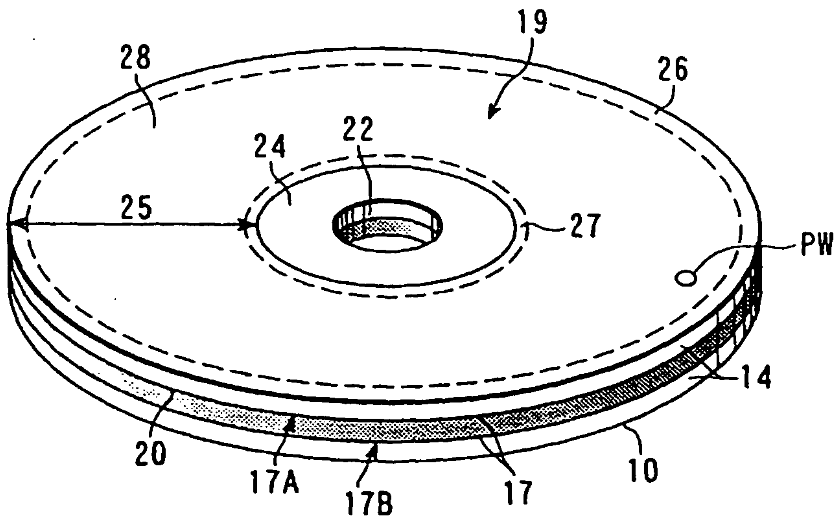
19
28
26
24
22
25
27
PW
14
20
17A
17B
17
10

FIG. 1A

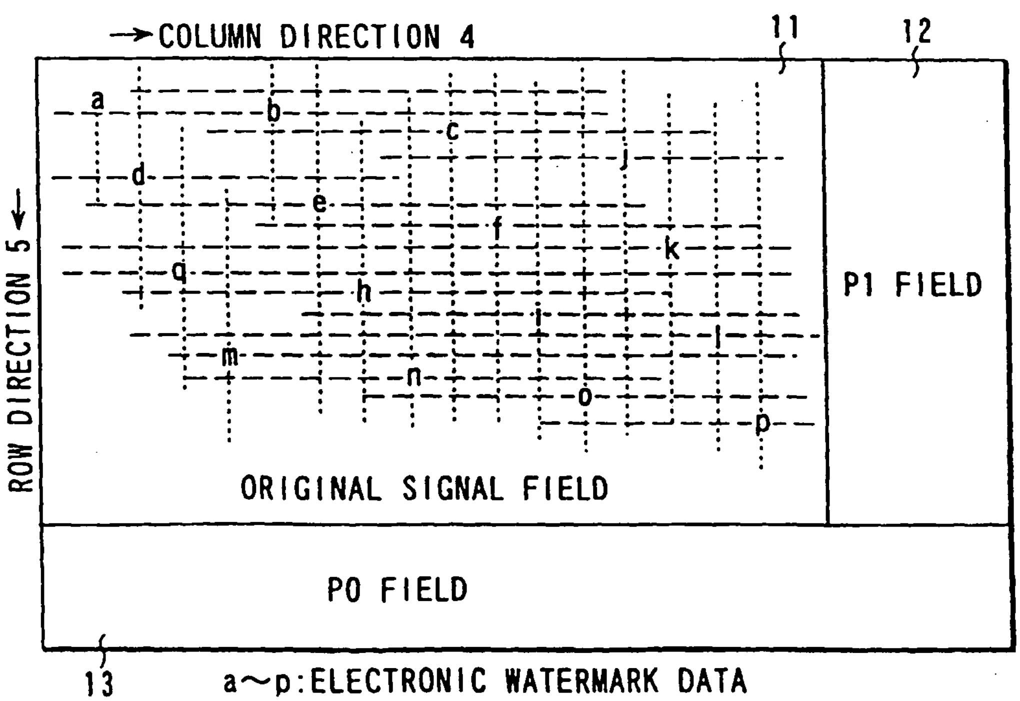
COLUMN DIRECTION 4
11
12
ROW DIRECTION 5
a
b
c
d
e
f
g
h
i
j
k
l
m
n
o
p
P1 FIELD
ORIGINAL SIGNAL FIELD
PO FIELD
13
a~p:ELECTRONIC WATERMARK DATA

FIG. 1B

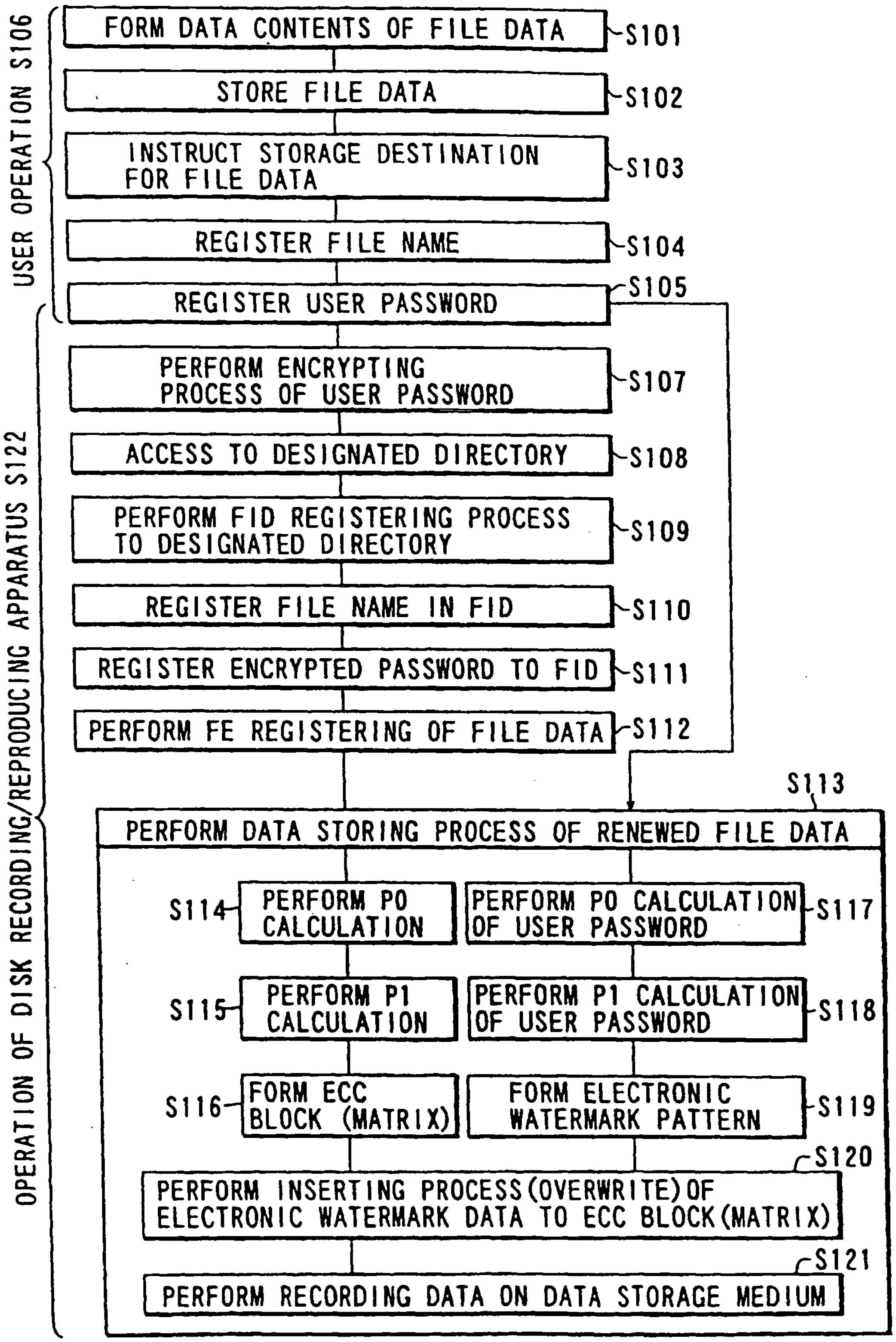
USER OPERATION S106
FORM DATA CONTENTS OF FILE DATA
S101
STORE FILE DATA
S102
INSTRUCT STORAGE DESTINATION FOR FILE DATA
S103
REGISTER FILE NAME
S104
REGISTER USER PASSWORD
S105
OPERATION OF DISK RECORDING/REPRODUCING APPARATUS S122
PERFORM ENCRYPTING PROCESS OF USER PASSWORD
S107
ACCESS TO DESIGNATED DIRECTORY
S108
PERFORM FID REGISTERING PROCESS TO DESIGNATED DIRECTORY
S109
REGISTER FILE NAME IN FID
S110
REGISTER ENCRYPTED PASSWORD TO FID
S111
PERFORM FE REGISTERING OF FILE DATA
S112
S113
PERFORM DATA STORING PROCESS OF RENEWED FILE DATA
S114
PERFORM P0 CALCULATION
PERFORM P0 CALCULATION OF USER PASSWORD
S117
S115
PERFORM P1 CALCULATION
PERFORM P1 CALCULATION OF USER PASSWORD
S118
S116
FORM ECC BLOCK (MATRIX)
FORM ELECTRONIC WATERMARK PATTERN
S119
S120
PERFORM INSERTING PROCESS (OVERWRITE) OF ELECTRONIC WATERMARK DATA TO ECC BLOCK (MATRIX)
S121
PERFORM RECORDING DATA ON DATA STORAGE MEDIUM

FIG. 2

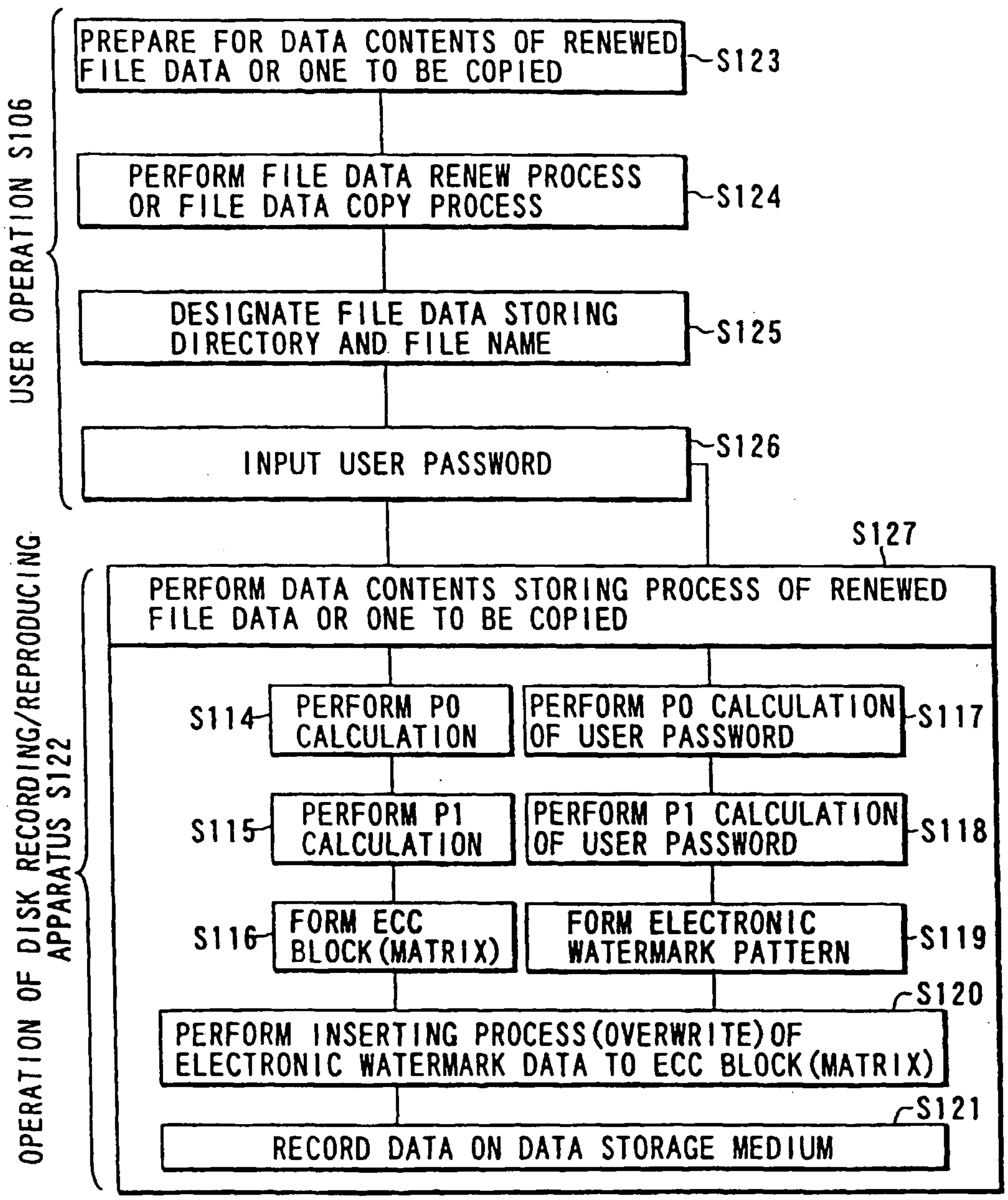
USER OPERATION S106
PREPARE FOR DATA CONTENTS OF RENEWED FILE DATA OR ONE TO BE COPIED
S123
PERFORM FILE DATA RENEW PROCESS OR FILE DATA COPY PROCESS
S124
DESIGNATE FILE DATA STORING DIRECTORY AND FILE NAME
S125
INPUT USER PASSWORD
S126
OPERATION OF DISK RECORDING/REPRODUCING APPARATUS S122
S127
PERFORM DATA CONTENTS STORING PROCESS OF RENEWED FILE DATA OR ONE TO BE COPIED
S114
PERFORM PO CALCULATION
PERFORM PO CALCULATION OF USER PASSWORD
S117
S115
PERFORM P1 CALCULATION
PERFORM P1 CALCULATION OF USER PASSWORD
S118
S116
FORM ECC BLOCK(MATRIX)
FORM ELECTRONIC WATERMARK PATTERN
S119
S120
PERFORM INSERTING PROCESS(OVERWRITE)OF ELECTRONIC WATERMARK DATA TO ECC BLOCK(MATRIX)
S121
RECORD DATA ON DATA STORAGE MEDIUM

FIG. 3

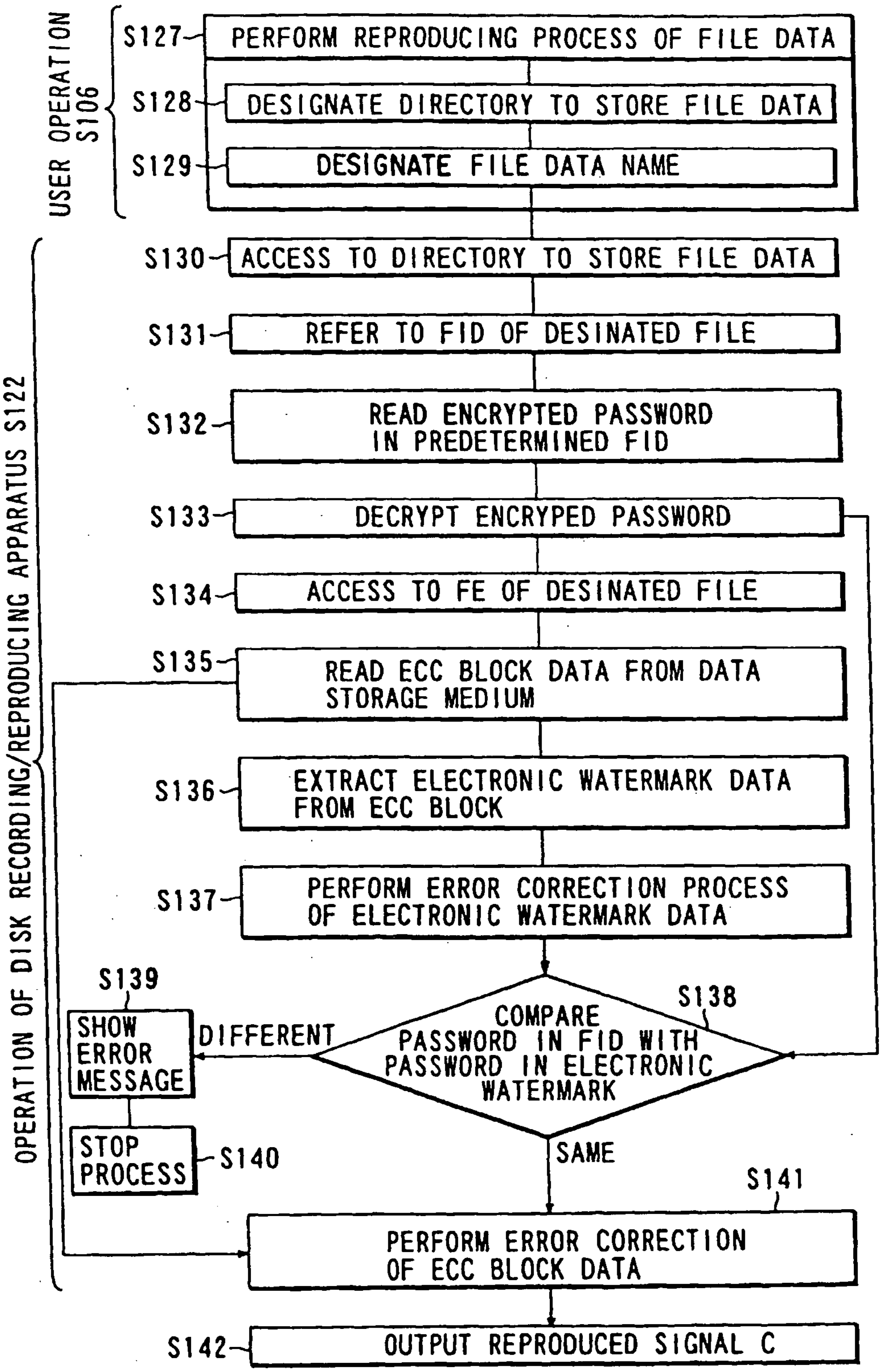
USER OPERATION S106
S127
PERFORM REPRODUCING PROCESS OF FILE DATA
S128
DESIGNATE DIRECTORY TO STORE FILE DATA
S129
DESIGNATE FILE DATA NAME
OPERATION OF DISK RECORDING/REPRODUCING APPARATUS S122
S130
ACCESS TO DIRECTORY TO STORE FILE DATA
S131
REFER TO FID OF DESINATED FILE
S132
READ ENCRYPTED PASSWORD IN PREDETERMINED FID
S133
DECRYPT ENCRYPED PASSWORD
S134
ACCESS TO FE OF DESINATED FILE
S135
READ ECC BLOCK DATA FROM DATA STORAGE MEDIUM
S136
EXTRACT ELECTRONIC WATERMARK DATA FROM ECC BLOCK
S137
PERFORM ERROR CORRECTION PROCESS OF ELECTRONIC WATERMARK DATA
S138
COMPARE PASSWORD IN FID WITH PASSWORD IN ELECTRONIC WATERMARK
DIFFERENT
S139
SHOW ERROR MESSAGE
STOP PROCESS
S140
SAME
S141
PERFORM ERROR CORRECTION OF ECC BLOCK DATA
S142
OUTPUT REPRODUCED SIGNAL C

FIG. 4

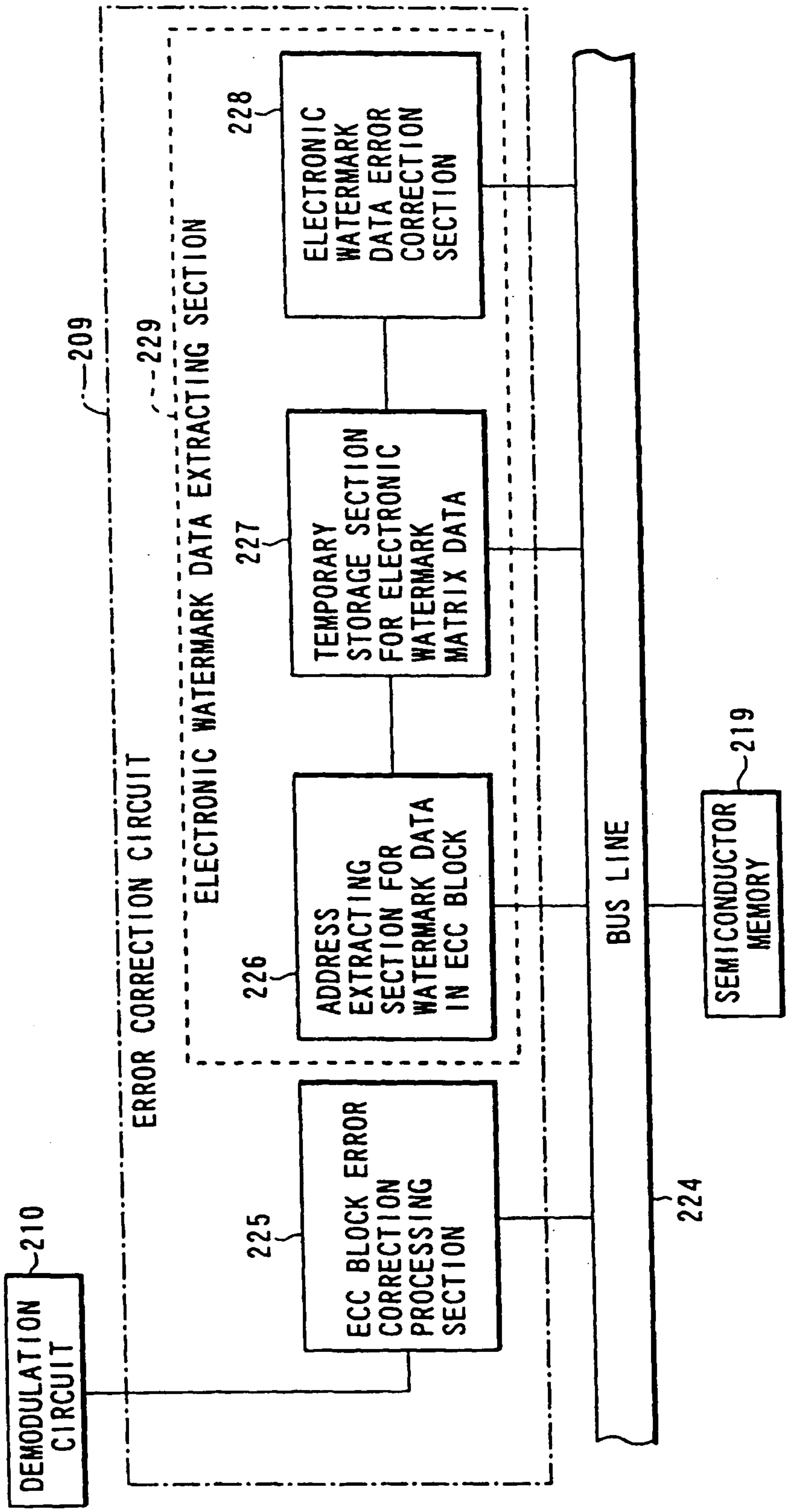
ERROR CORRECTION CIRCUIT
209
ELECTRONIC WATERMARK DATA EXTRACTING SECTION
229
228
ELECTRONIC WATERMARK DATA ERROR CORRECTION SECTION
227
TEMPORARY STORAGE SECTION FOR ELECTRONIC WATERMARK MATRIX DATA
226
ADDRESS EXTRACTING SECTION FOR WATERMARK DATA IN ECC BLOCK
225
ECC BLOCK ERROR CORRECTION PROCESSING SECTION
DEMODULATION CIRCUIT
210
BUS LINE
224
SEMICONDUCTOR MEMORY
219

FIG. 5

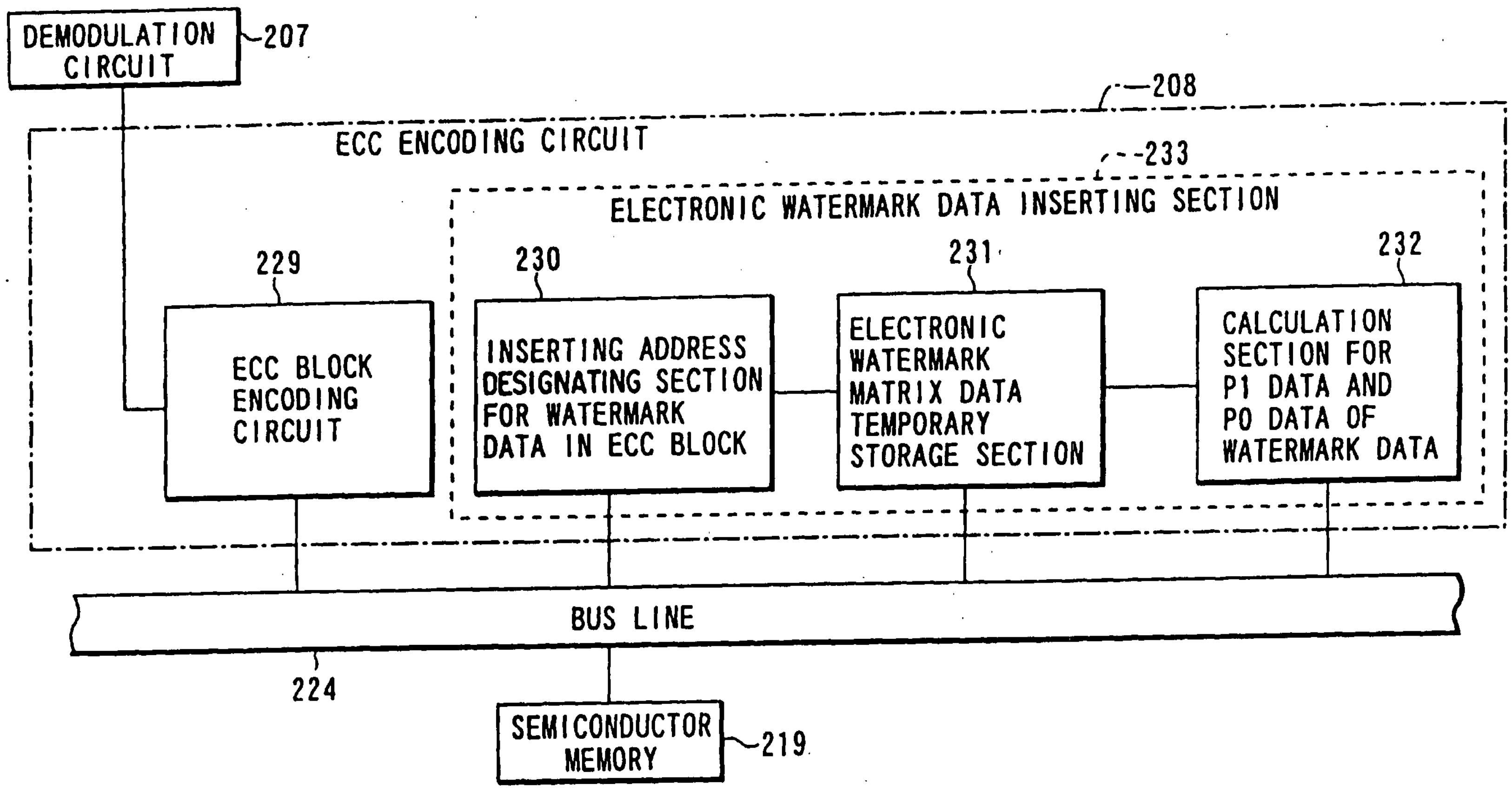
DEMODULATION CIRCUIT
207
208
ECC ENCODING CIRCUIT
233
ELECTRONIC WATERMARK DATA INSERTING SECTION
229
ECC BLOCK ENCODING CIRCUIT
230
INSERTING ADDRESS DESIGNATING SECTION FOR WATERMARK DATA IN ECC BLOCK
231
ELECTRONIC WATERMARK MATRIX DATA TEMPORARY STORAGE SECTION
232
CALCULATION SECTION FOR P1 DATA AND P0 DATA OF WATERMARK DATA
BUS LINE
224
SEMICONDUCTOR MEMORY
219

FIG. 6

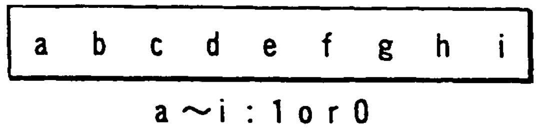


FIG. 7A

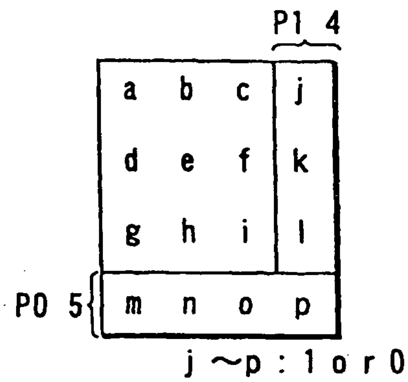


FIG. 7B

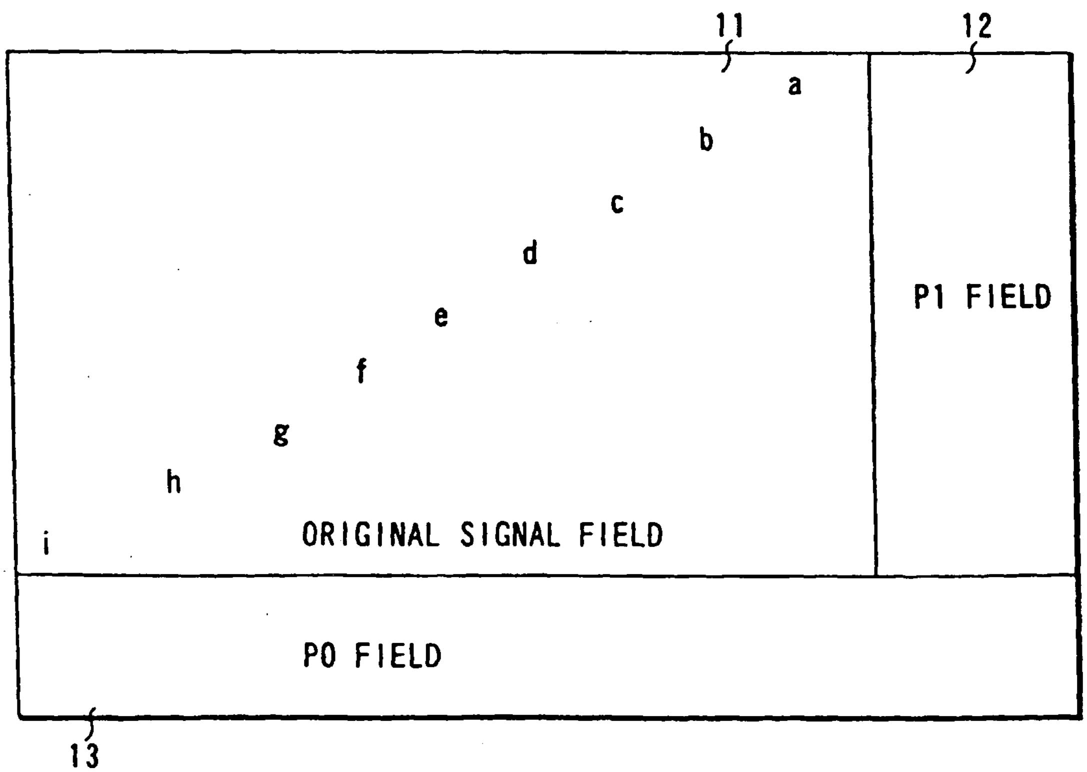


FIG. 8

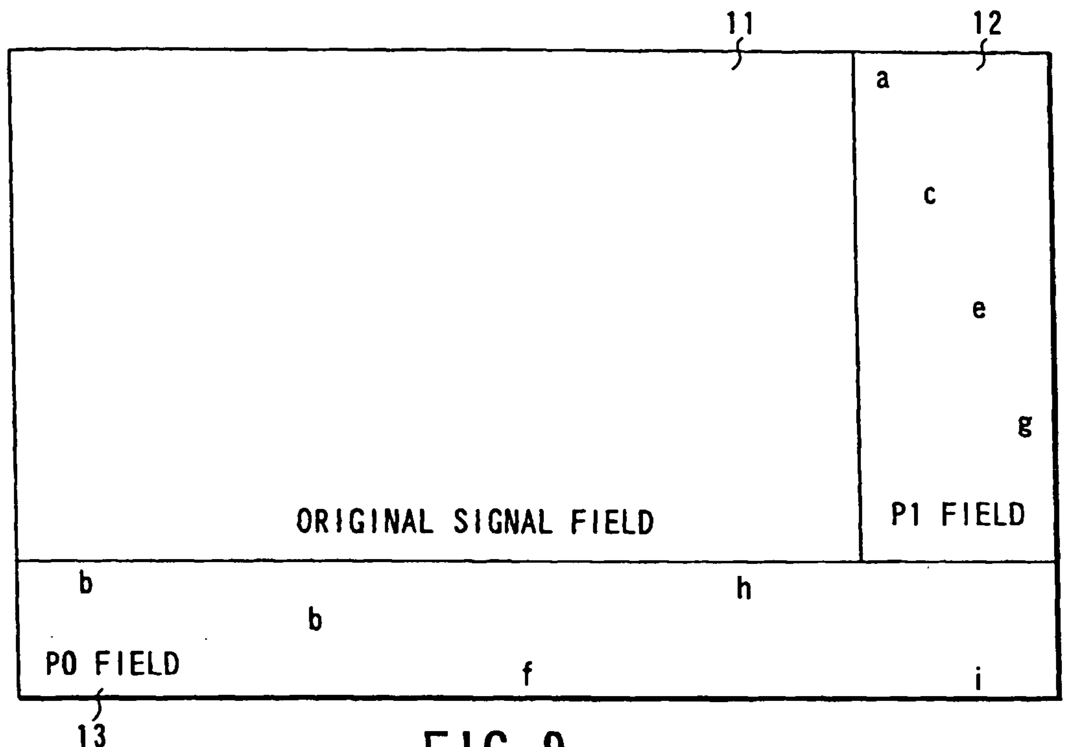
11
12
a
c
e
g
ORIGINAL SIGNAL FIELD
P1 FIELD
b
h
b
P0 FIELD
f
i
13

FIG. 9

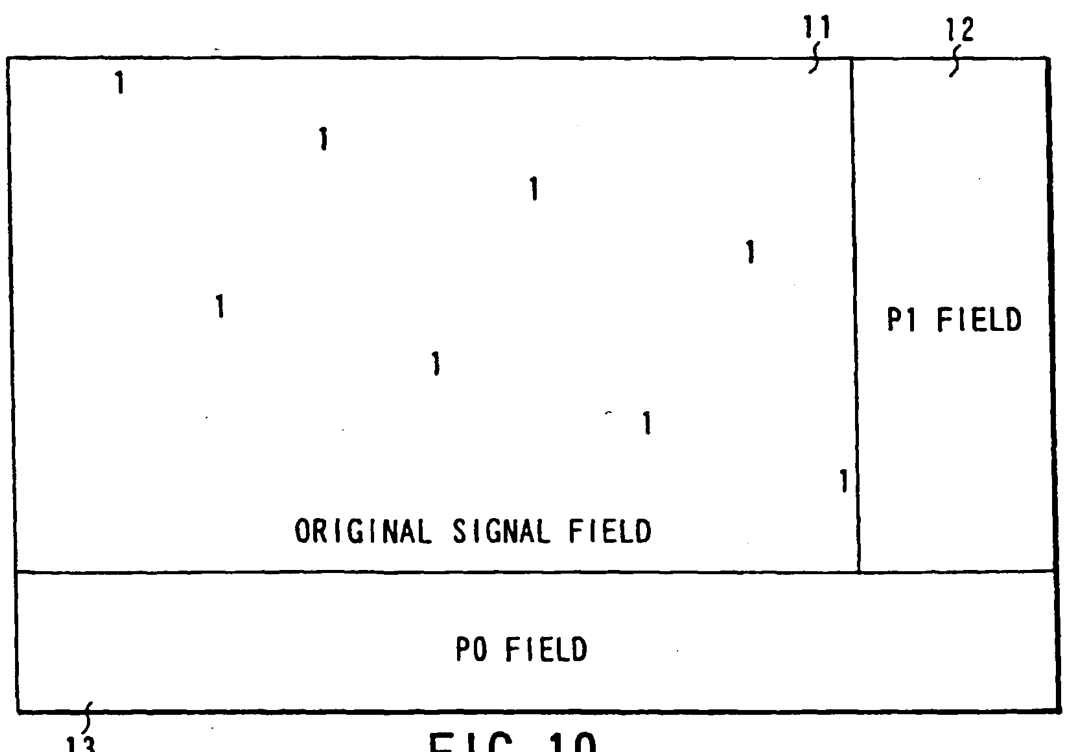
11
12
1
1
1
1
1
1
1
1
P1 FIELD
ORIGINAL SIGNAL FIELD
P0 FIELD
13

FIG. 10

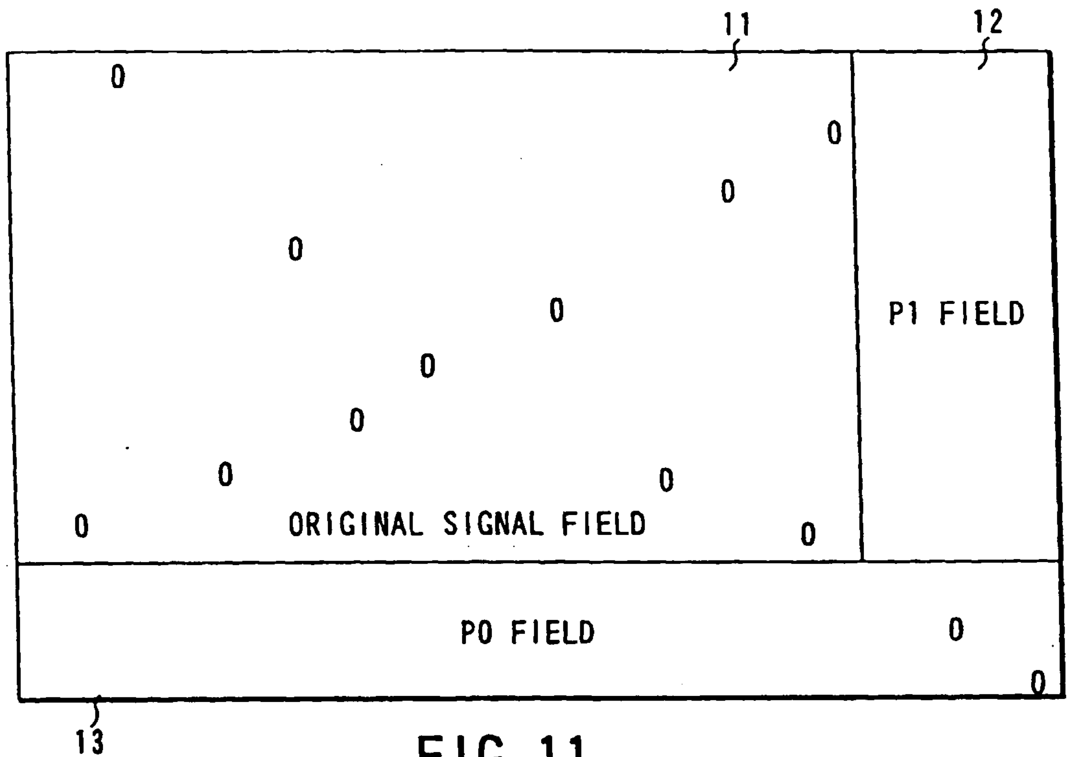
11
12
0
0
0
0
0
P1 FIELD
0
0
0
0
0 ORIGINAL SIGNAL FIELD
0
P0 FIELD
0
0
13

FIG. 11

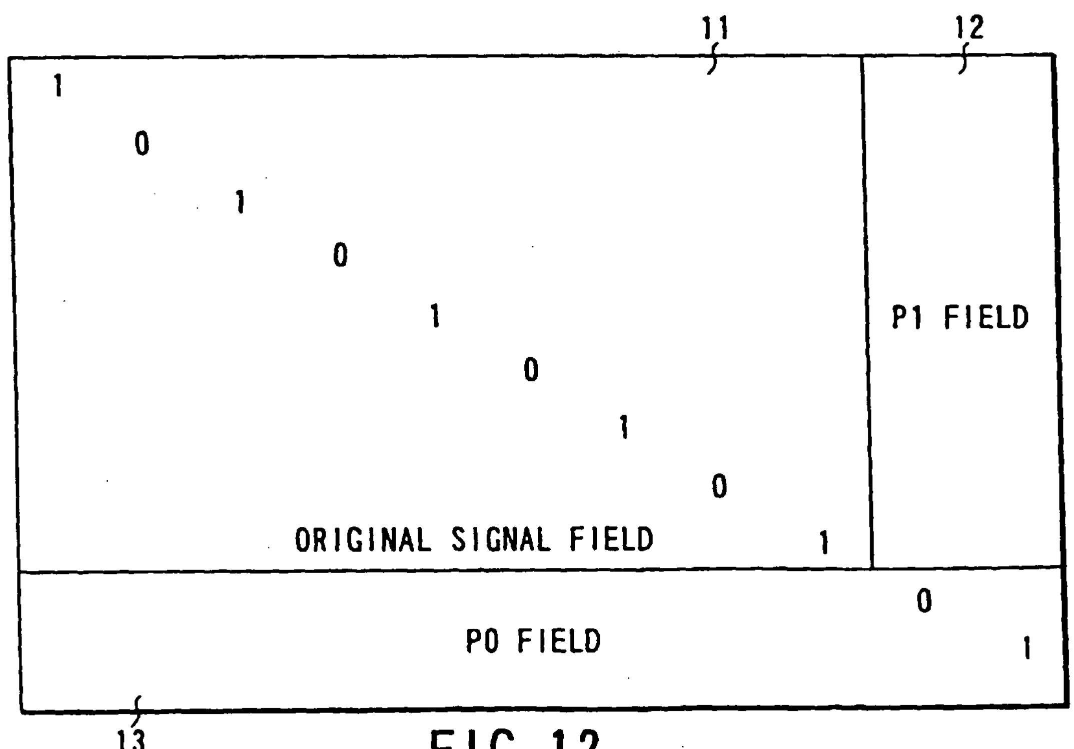
11
12
1
0
1
0
1
P1 FIELD
0
1
0
ORIGINAL SIGNAL FIELD
1
0
P0 FIELD
1
13

FIG. 12

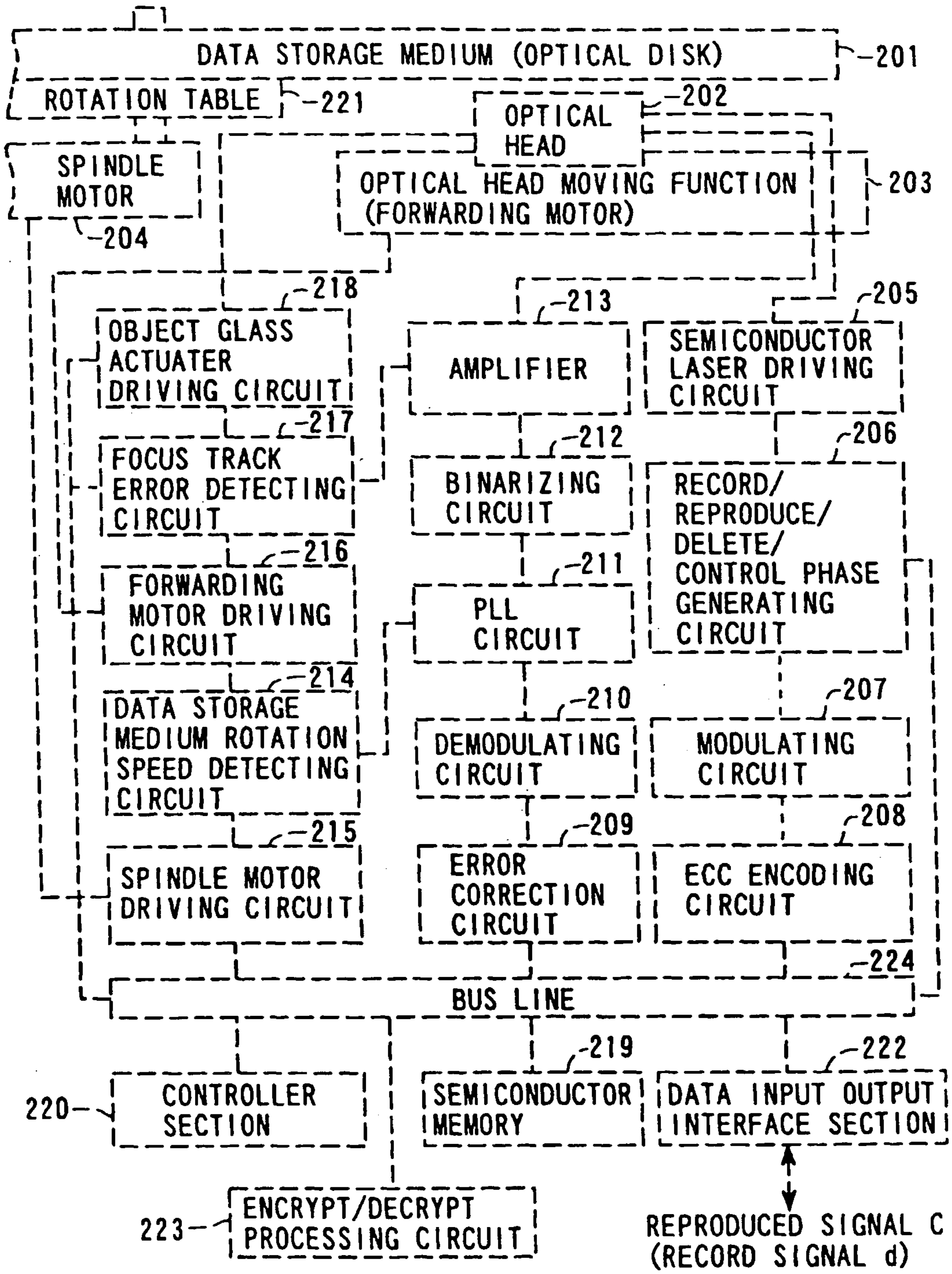
DATA STORAGE MEDIUM (OPTICAL DISK)
201
ROTATION TABLE
221
OPTICAL HEAD
202
SPINDLE MOTOR
204
OPTICAL HEAD MOVING FUNCTION (FORWARDING MOTOR)
203
OBJECT GLASS ACTUATER DRIVING CIRCUIT
218
AMPLIFIER
213
SEMICONDUCTOR LASER DRIVING CIRCUIT
205
FOCUS TRACK ERROR DETECTING CIRCUIT
217
BINARIZING CIRCUIT
212
RECORD/ REPRODUCE/ DELETE/ CONTROL PHASE GENERATING CIRCUIT
206
FORWARDING MOTOR DRIVING CIRCUIT
216
PLL CIRCUIT
211
DATA STORAGE MEDIUM ROTATION SPEED DETECTING CIRCUIT
214
DEMODULATING CIRCUIT
210
MODULATING CIRCUIT
207
SPINDLE MOTOR DRIVING CIRCUIT
215
ERROR CORRECTION CIRCUIT
209
ECC ENCODING CIRCUIT
208
BUS LINE
224
CONTROLLER SECTION
220
SEMICONDUCTOR MEMORY
219
DATA INPUT OUTPUT INTERFACE SECTION
222
ENCRYPT/DECRYPT PROCESSING CIRCUIT
223
REPRODUCED SIGNAL C
(RECORD SIGNAL d)

FIG. 13

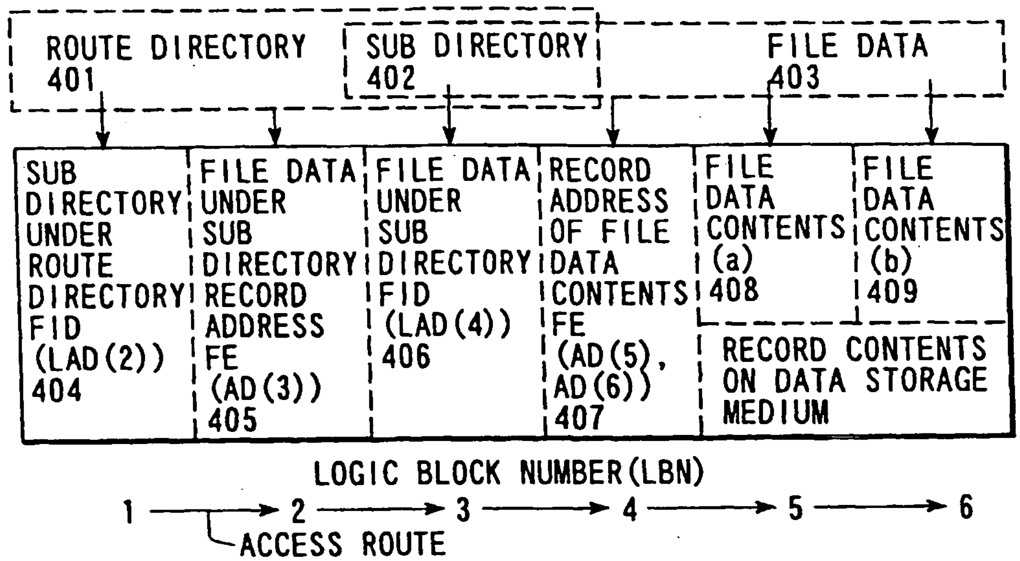


FIG. 14

LAD(LOGIC BLOCK NUMBER)
···RECORD ADDRESS OF EXTENT ON DATA STORAGE MEDIUM

| | | |
|---|---|---|
| LENGTH OF EXTENT 410 (LOGIC BLOCK NUMBER) [4 BYTE] | ADDRESS OF EXTENT 411 (LOGIC BLOCK NUMBER) [4 BYTE] | IMPLEMENTATION USE 412 (DATA FOR ARITHMETIC PROCESS) [8 BYTE] |

FIG. 15

AD(LOGIC BLOCK NUMBER)
···RECORD ADDRESS OF EXTENT ON DATA STORAGE MEDIUM

| | |
|---|---|
| LENGTH OF EXTENT 410 (LOGIC BLOCK NUMBER) [4 BYTE] | ADDRESS OF EXTENT 411 (LOGIC BLOCK NUMBER) [4 BYTE] |

FIG. 16

USE(AD(*), AD(*), ···, AD(*))
···REFER TO EXTENT BEING NOT RECORDED,
USE BY DESCRIPTIVE AS SPACE TABLE

| | | | |
|---|---|---|---|
| DESCRIPTIVE TAG(≡ 263) IDENTIFIER OF DESCRIPTION CONTENTS 413 [16 BYTES] | TYPE OF ICB TAG FILE (TYPE=1) 414 [20 BYTES] | LENGTH OF ALLOCATION DESCRIPTIVE (BYTE LENGTH) 415 [4 BYTES] | ADDRESSES ON MEDIUM OF ALLOCATION DESCRIPTIVE EACH EXTENT ARE SHOWED SIDE BY SIDE (AD(*), AD(*), ···, AD(*)) 416 |

FIG. 17

FE(AD(*), AD(*), ···, AD(*))
···RECORD ADDRESS ON STORAGE MEDIUM OF FILE
DESIGNATED IN FID IN LAYERED DIRECTORY

| | | | |
|---|---|---|---|
| DESCRIPTIVE TAG(≡ 261) IDENIFIER OF DESCRIPTION CONTENTS [16 BYTES] | TYPE OF ICB TAG FILE (TYPE=4/5) 418 [20 BYTES] | PERMISSION DATA FOR RECORD, REPRODUCE, DELETE EVERY PERMISSION USERS 419 [32 BYTES] | ADDRESSES ON MEDIUM OF ALLOCATION DESCRIPTIVE EACH EXTENT ARE SHOWED SIDE BY SIDE (AD(*), AD(*), ···, AD(*)) 420 |

FIG. 18

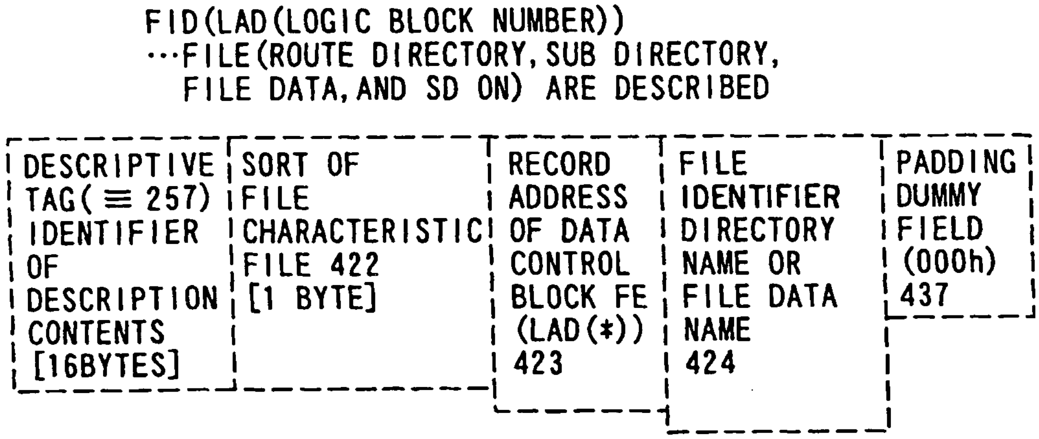
FID(LAD(LOGIC BLOCK NUMBER))
···FILE(ROUTE DIRECTORY, SUB DIRECTORY, FILE DATA, AND SD ON) ARE DESCRIBED
DESCRIPTIVE TAG(≡ 257) IDENTIFIER OF DESCRIPTION CONTENTS [16BYTES]
SORT OF FILE CHARACTERISTIC FILE 422 [1 BYTE]
RECORD ADDRESS OF DATA CONTROL BLOCK FE (LAD(*)) 423
FILE IDENTIFIER DIRECTORY NAME OR FILE DATA NAME 424
PADDING DUMMY FIELD (000h) 437

FIG. 19

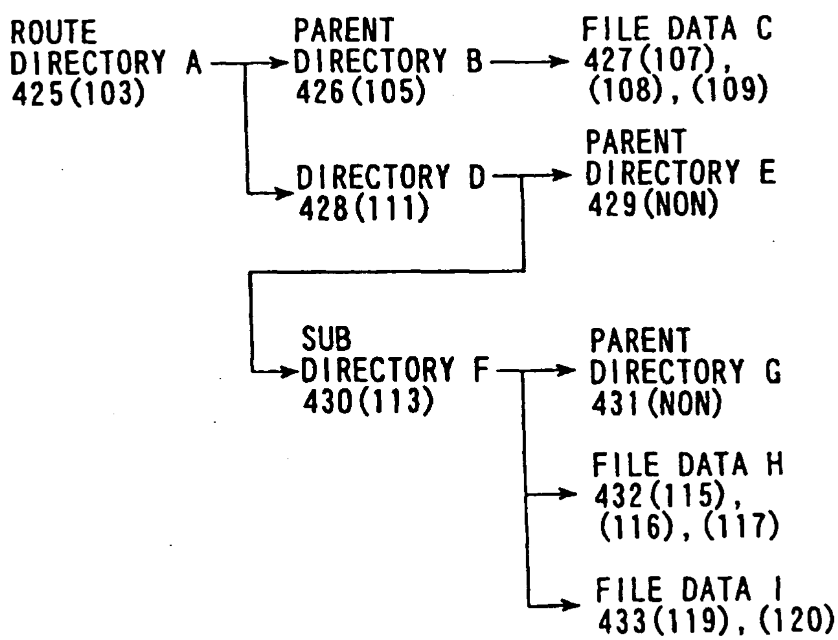
ROUTE DIRECTORY A 425(103)
PARENT DIRECTORY B 426(105)
FILE DATA C 427(107), (108), (109)
DIRECTORY D 428(111)
PARENT DIRECTORY E 429(NON)
SUB DIRECTORY F 430(113)
PARENT DIRECTORY G 431(NON)
FILE DATA H 432(115), (116), (117)
FILE DATA I 433(119), (120)

FIG. 20

| LSN | LBN | STRUCTURE 441 | DESCRIPTIVE 442 | CONTENTS 443 |
|---|---|---|---|---|
| 0～15 | | | RESERVE 459 (ALL 00h BYTE) | |
| 16 | | VOLUME RECOGNITION SEQUENCE 444 | EXTENT AREA DESCRIPTIVE START 445 | VRS START ADDRESS |
| 17 | | | VOLUME STRUCTURE DESCRIPTIVE 446 | DESK CONTENTS EXPLANATION |
| 18 | | | BOOT DESCRIPTIVE 447 | BOOT START ADDRESS |
| 19 | | | EXTENT AREA DESCRIPTIVE END 448 | VRS END ADDRESS |
| ～31 | | | RESERVE (ALL 00h BYTE) | |
| 32～ | | MAIN VOLUME DESCRIPTIVE SEQUENCE 449 | OMIT | |
| 34 | | | PARTITION DESCRIPTIVE 450<br>PARTITION CONTENTS USAGE 451<br>SPACE TABLE NOT TO ALOCATE 452 AD(80)<br>SPACE BIT MAP NOT TO ALOCATE 453 AD(0) | RECORD ADDRESS OF SPACE TABLE<br>RECORD ADDRESS OF SPACE BIT MAP |
| 35 | | | LOGIC VOLUME DESCRIPTIVE 454<br>LOGIC VOLUME CONTENTS USAGE 455 LAD(100) | RECORD ADDRESS OF FILE SET DESCRIPTIVE 472 |
| ～47 | | | OMIT | |
| ～63 | | | OMIT | |
| ～255 | | | RESERVE 461 (ALL 00h BYTE) | |
| 256 | | FIRST ANCHOR POINT 456 | ANCHOR VOLUME DESCRIPTIVE POINTER 458 | |
| ～271 | | | RESERVE 462 (ALL 00h BYTE) | |
| | | | | |

FIG. 21

| | | | | |
|---|---|---|---|---|
| 272 ~ 321 | 0 ~ 49 | FILE STRUCTURE 486 | SPACE BIT MAP DESCRIPTIVE 470 | MAPPING OF SPACE BIT MAP RECORD, NON-RECORD |
| 322 ~ 371 | 50 ~ 99 | | USE(AD(*), AD(*), ···, AD(*)) 471 | EXTENT LIST OF STATUS OF NON RECORDED OF SPACE TABLE |
| 372 | 100 | | FILE SET DESCRIPTIVE 472, ROUTE DIRECTORY ICB473; LAD(102) 474 | RECORD ADDRESS OF ROUTE DIRECTORY |
| 373 | 101 | | OMIT | |
| 374 | 102 | | ROUTE DIRECTORY AFE(AD(103)) 475 | RECORD ADDRESS OF FIDs |
| 375 | 103 | | FID IN A (LAD(104), LAD(110)) 476 | ADDRESS OF B, D |
| 376 | 104 | | PARENT DERECTORY EFE (AD(105)) 477 | RECORD ADDRESS OF FIDs |
| 377 | 105 | | FID IN B (LAD(106)) 478 | ADDRESS OF C |
| 378 | 106 | | FE(AD(107) AD(108) AD(109)) 479 | FILE DATA ADDRESS |
| 382 | 110 | | FE IN DIRECTORY (AD(111)) 480 | ADDRESS OF FIDs |
| 383 | 111 | | FID IN D (LAD(112), LAD(NON)) 481 | ADDRESS OF E, F |
| 384 | 112 | | FE IN SUB DIRECTORY FE(AD(113)) 482 | RECORD ADDRESS OF FIDs |
| 385 | 113 | | FID(LAD(NON), LAD (114), LAD(118)) 483 | ADDRESS OF H, I |
| 386 | 114 | | FE(AD(115) AD(116) AD(117)) 484 | ADDRESS OF FILE DATA |
| 390 | 118 | | FE IN I (AD(119), AD (120)) 485 | ADDRESS OF FILE DATA |
| 379~ | 107~ | FILE DATA 487 | DATA OF FILE DATA C 488 | |
| 387~ | 115~ | | DATA OF FILE DATA H 489 | |
| 391~ | 119~ | | DATA OF FILE DATA I 490 | |
| | | | | |

FIG. 22

| | | | |
|---|---|---|---|
| LLSN-271 ~ LLSN-257 | | RESERVE 463 (ALL 00h BYTE) | |
| LLSN-256 | SECOND ANCHOR POINT 457 | ANCHOR VOLUME DESCRIPTIVE POINTER 458 | |
| LLSN-255 ~ LLSN-224 | | RESERVE 464 (ALL 00h BYTE) | |
| LLSN-223 ~ LLSN-208 | RESERVE VOLUME DESCRIPTIVE SEQUENCE 467 | PARTITION DESCRIPTIVE 450<br>PARTITION CONTENTS USAGE 451<br>SPACE TABLE NOT TO ALOCATE 452<br>SPACE BIT MAM NOT TO ALOCATE 453<br>LOGIC VOLUME DESCRIPTIVE 454<br>LOGIC VOLUME CONTENTS USAGE 455 | BACK UP OF MAIN VOLUME DESCRIPTIVE SEQUENCE |
| LLSN-207 ~ LLSN | | RESERVE 465 (ALL 00h BYTE) | |

FIG. 23